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Documentation of the Canyon Creek Fire. (Volume 2)

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November 4, 1991

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Abstract

The Canyon Creek Fire was initially a free-burning natural prescribed fire within the Scapegoat Wilderness of north-central Montana, USA managed by the United States Forest Service. The lightning caused fire burned for 112 days through high elevation mixed conifer and lodgepole pine forests. During the life of the fire six crown fire runs in excess of 4,000 acres occurred, the largest of which was during the burning period of September 6 and 7 which burned approximately 117,330 acres. This crown fire run burned through rugged mountainous terrain along an approximate 65 mile long fire front, covering a distance of about 21 miles in 5.5 hours. The crown fire run averaged approximately 2.9 miles/hr, with peak rates-of-spread observed to be 9.0 miles/hr under the influence of a surfacing low level jet stream. This is the greatest documented conifer forest crown fire rate-of-spread in the United States. The fire was being actively managed as a wildfire prior to this crown fire run and remained so until the fire was declared controlled October 14th under a cover of snow. Final within perimeter acreage of the Canyon Creek Fire was 188,071 acres.

Table of Contents

Section		Page
1.0.0	Scapegoat Wilderness Area Topography	1
2.0.0	Fire History and Forest Succession	3
2.1.0	Relationship of Major Tree Species to Fire	4
2.1.1	Limber Pine (Pinus flexilis), (PIFL)	4
2.1.2	Ponderosa Pine (Pinus ponderosa), (PIPO)	5
2.1.3	Douglas-fir (Pseudotsuga mengziesii), (PSME)	6
2.1.4	Engelmann Spruce (Picea engelmannii), (PIEN)	9
2.1.5	Lodgepole Pine (Pinus contorta), (PICO)	9
2.1.6	Western Larch (Larix occidentalis), (LAOC)	10
2.1.7	Subalpine Fir (Abies lasiocarpa), (ABLA)	11
2.1.8	Subalpine Larch (Larix lyallii), (LALY)	11
2.1.9	Whitebark Pine (Pinus albicaulis), (PIAL)	11
2.2.0	Fire Group Zero: Miscellaneous Special Habitats	12
2.2.1	Scree	12
2.2.2	Forested Rock	13
2.2.3	Wet, Grass-Sedge Meadow	13
2.2.4	Mountain Grassland	14
2.2.5	Aspen Grove	14
2.2.6	Alder Glade	15
2.3.0	Fire Group One: Dry Limber Pine Habitat Types	15
2.3.1	Forest Fuel	15
2.3.2	Role of Fire	16
2.3.3	Generalized Forest Succession	16
2.4.0	Fire Group Two: Warm, Dry Ponderosa Pine Habitat Types	18
2.4.1	Forest Fuel	18
2.4.2	Role of Fire	19
2.4.3	Generalized Forest Succession	19
2.5.0	Fire Group Four: Warm, Dry Douglas-fir Habitat Types	21
2.5.1	Forest Fuel	21
2.5.2	Role of Fire	21
2.5.3	Generalized Forest Succession	22
2.6.0	Fire Group Five: Cool, Dry Douglas-fir Habitat Types	24
2.6.1	Forest Fuel	24
2.6.2	Role of Fire	24
2.6.3	Generalized Forest Succession	25
2.7.0	Fire Group Six: Moist, Douglas-fir Habitat Types	25
2.7.1	Forest Fuel	27
2.7.2	Role of Fire	27
2.7.3	Generalized Forest Succession	28
2.8.0	Fire Group Seven: Cool Habitat Types usually dominated by Lodgepole Pine	28
2.8.1	Forest Fuel	30
2.8.2	Role of Fire	31
2.8.3	Generalized Forest Succession	32
2.9.0	Fire Group Eight: Dry, Lower Subalpine Habitat Types	34
2.9.1	Forest Fuel	35
2.9.2	Role of Fire	35
2.9.3	Generalized Forest Succession	36
2.10.0	Fire Group Nine: Moist, Lower Subalpine Habitat Types	36

Table of Contents (Continued)

Section		Page
2.10.1	Forest Fuel	37
2.10.2	Role of Fire	37
2.10.3	Generalized Forest Succession	38
2.11.0	Fire Group Ten: Cold, Moist Upper Subalpine and Timberline Habitat Types	40
2.11.1	Forest Fuel	41
2.11.2	Role of Fire	41
2.11.3	Generalized Forest Succession	42
2.12.0	Scapegoat Wilderness Fire History	42
3.0.0	Climatology	51
3.1.0	West Side Climatological Characteristics and Comparisons with 1988	55
3.1.1	Lincoln Ranger Station, Helena National Forest	55
3.1.1.1	Precipitation	56
3.1.1.2	Temperature	61
3.1.1.3	Relative Humidity	64
3.1.1.4	Winds	64
3.1.1.5	3-Way Co-occurrence of Extreme Burning Conditions and the Rxburn Program	67
3.1.2	Silver King Lookout NFDRS Station, Helena National Forest	69
3.1.2.1	Precipitation	69
3.1.2.2	Temperature	69
3.1.2.3	Relative Humidity	70
3.1.2.4	Winds	70
3.1.2.5	3-Way Co-occurrence of Extreme Burning Conditions and the Rxburn Program	71
3.1.3	Ovando, Montana	72
3.1.3.1	Precipitation	72
3.1.3.2	Temperature	73
3.1.4	Seeley Lake Ranger Station, Lolo National Forest	73
3.1.4.1	Precipitation	74
3.1.4.2	Temperature	74
3.1.4.3	Relative Humidity	75
3.1.4.4	Winds	76
3.1.4.5	3-Way Co-occurrence of Extreme Burning Conditions and the Rxburn Program	76
3.1.4.6	Stream Flow of the Blackfoot River near Bonner	77
3.2.0	East Side Climatological Characteristics and Comparison with 1988	77
3.2.1	Augusta, Montana	77
3.2.1.1	Precipitation	77
3.2.1.2	Reservoir Storage	81
3.2.1.3	Temperature	81
3.2.2	Gibson Dam	84
3.2.2.1	Precipitation	84
3.2.2.2	Stream Flow at Gibson Dam	84
3.2.2.3	Reservoir Storage behind Gibson Dam	85
3.2.2.4	Temperature	85
3.2.3	Choteau, Montana	85

Table of Contents (Continued)

Section		Page
3.2.3.1	Precipitation	85
3.2.3.2	Temperature	86
3.2.4	Gleason's Resort NFDRS Station, Montana	86
3.2.4.1	Precipitation	87
3.2.4.2	Temperature	87
3.2.4.3	Relative Humidity	87
3.2.4.4	Winds	88
3.2.4.5	3-Way Co-occurrence of Extreme Burning Conditions and the Rxburn Program	88
3.3.0	Climatic Characteristics of Severe Fire Seasons and the 1988 Season	89
4.0.0	Fire Danger	94
4.1.0	West Side Fire Danger and Comparisons with 1988	96
4.1.1	Lincoln Ranger Station, Helena National Forest	96
4.1.2	Energy Release Component	96
4.1.3	Burning Index	98
4.1.4	Thousand Hour Fuel Moisture	100
4.2.1	Silver King Lookout, Helena National Forest	102
4.2.2	Energy Release Component	102
4.2.3	Burning Index	102
4.2.4	Thousand Hour Fuel Moisture	105
4.3.1	Seeley Lake Ranger Station, Lolo National Forest	107
4.3.2	Energy Release Component	107
4.3.3	Burning Index	107
4.3.4	Thousand Hour Fuel Moisture	109
4.4.1	Spotted Bear Lookout NFDRS Station, Flathead National Forest	112
4.4.2	Energy Release Component	112
4.4.3	Burning Index	114
4.4.4	Thousand Hour Fuel Moisture	114
4.5.1	Spotted Bear Ranger Station, Flathead National Forest	117
4.5.2	Energy Release Component	117
4.5.3	Burning Index	119
4.5.4	Thousand Hour Fuel Moisture	121
4.2.0	East Side Fire Danger and Comparisons with 1988	123
4.2.1	Gleason's Resort NFDRS Station	123
4.2.2	Energy Release Component	123
4.2.3	Burning Index	125
4.2.4	Thousand Hour Fuel Moisture	125
5.0.0	Canyon Creek Fire; Fire Behavior, Fire Weather, and Fuel Moisture Chronology	129
6.0.0	Literature Cited	374

Figures

		Page
Figure 1.	Steamboat Mountain; July 10, 1921 by W. C. Alden (Gruell, 1983 Plate 26a).	7
Figure 2.	Steamboat Mountain; September 7, 1981 by R. F. Well (Gruell, 1983 Plate 26b).	8
Figure 3.	Generalized Forest succession in Fire Group One: limber pine climax series habitat types.	17
Figure 4.	Generalized Forest succession in Fire Group Two: warm, dry ponderosa pine habitat types.	20
Figure 5.	Generalized Forest succession in Fire Group Four: warm, dry Douglas-fir habitat types.	23
Figure 6.	Generalized Forest succession in Fire Group Five: cool, dry Douglas-fir habitat types.	26
Figure 7.	Generalized Forest succession in Fire Group Six: moist Douglas-fir habitat types.	29
Figure 8.	Generalized Forest succession in Fire Group Seven: cool habitat types usually dominated by lodgepole pine.	33
Figure 9.	Generalized Forest succession in Fire Group Eight: dry, lower subalpine habitat types; and in Fire Group Nine: moist, lower subalpine habitat types.	39
Figure 10.	Generalized Forest succession in Fire Group Ten: cold, moist upper subalpine and timberline habitat types.	43
Figure 11.	Enlarged detail from the lower right-hand corner of Ayers (1901) map of the Lewis and Clark Reserve.	47
Figure 12.	Monthly percentage of total lightning caused fires for the Scapegoat Wilderness and surrounding portions of the Seeley Lake Ranger District (Lolo National Forest), and the Lincoln Ranger District (Helena National Forest).	53
Figure 13.	Actual distribution from the average of the annual lightning caused fires for the Scapegoat Wilderness and surrounding portions of the Seeley Lake Ranger District (Lolo National Forest), and the Lincoln Ranger District (Helena National Forest).	54
Figure 14.	Water Year (October - September) difference from average precipitation totals for the Ovando station, Seeley Lake Ranger Station (Lolo National Forest), and the Lincoln Ranger Station (Helena National Forest).	57

Figures (Continued)

		Page
Figure 15.	Difference from average of the annual precipitation at the Lincoln Ranger Station, Helena, National Forest for the years 1949 - 1988.	58
Figure 16.	Pre-fire season (October - June) difference from average precipitation totals for the Lincoln Ranger Station, Helena National Forest.	59
Figure 17.	Fire season (June - August) difference from average precipitation totals for the Ovando station, Seeley Lake Ranger Station (Lolo National Forest), and the Lincoln Ranger Station (Helena National Forest).	60
Figure 18.	1988 difference from average snow water equivalent from stations near the Scapegoat Wilderness.	62
Figure 19.	Difference from average of the annual (September - May) snowfall at the Lincoln Ranger Station, Helena National Forest for the 1949 - 1950 through 1987 - 1988 seasons.	63
Figure 20.	Difference from average of the average high temperatures for the June - August, June - October, and annual time periods at the Lincoln Ranger Station, Helena National Forest for 1967 - 1988.	65
Figure 21.	1988 Water Year (October - September) difference from average of the average monthly temperatures at the Seeley Lake Ranger Station (Lolo National Forest), and the Lincoln Ranger Station (Helena National Forest).	66
Figure 22.	Comparison of the 1988 Water Year (October - September) stream flow from the Sun River and Blackfoot River with their historical monthly average.	79
Figure 23.	Water Year (October - September) difference from average precipitation totals for the Augusta, Choteau, and Gibson Dam stations.	80
Figure 24.	Comparison of the 1988 Water Year (October - September) reservoir storage in the Gibson and Nilan Reservoirs with their historical monthly average.	82
Figure 25.	1988 Water Year (October - September) difference from average of the average monthly temperatures at the Augusta, Choteau, and Gibson Dam stations.	83

Figures (Continued)

		Page
Figure 26.	1988 Water Year (October - September) difference from average monthly precipitation totals, and cumulative deficit for the Ovando station, Seeley Lake Ranger Station (Lolo National Forest), and the Lincoln Ranger Station (Helna National Forest).	91
Figure 27.	1988 Water Year (October - September) difference from average monthly precipitation totals, and cumulative deficit for the Augusta, Choteau, and Gibson Dam stations.	92
Figure 28.	Energy Release Component for the Lincoln Ranger Station, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	97
Figure 29.	Burning Index for the Lincoln Ranger Station, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	99
Figure 30.	Thousand Hour Fuel Moisture for the Lincoln Ranger Station, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	101
Figure 31.	Energy Release Component for the Silver King Lookout NFDRS Station, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	103
Figure 32.	Burning Index for the Silver King Lookout NFDRS Station, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	104
Figure 33.	Thousand Hour Fuel Moisture for the Silver King Lookout NFDRS Station, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	106
Figure 34.	Energy Release Component for the Seeley Lake Ranger Station, Lolo National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	108
Figure 35.	Burning Index for the Seeley Lake Ranger Station, Lolo National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	110
Figure 36.	Thousand Hour Fuel Moisture for the Seeley Lake Ranger Station, Lolo National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	111

Figures (Continued)

		Page
Figure 37.	Energy Release Component for the Spotted Bear Lookout NFDRS Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	113
Figure 38.	Burning Index for the Spotted Bear Lookout NFDRS Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	115
Figure 39.	Thousand Hour Fuel Moisture for the Spotted Bear Lookout NFDRS Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	116
Figure 40.	Energy Release Component for the Spotted Bear Ranger Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	118
Figure 41.	Burning Index for the Spotted Bear Ranger Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	120
Figure 42.	Thousand Hour Fuel Moisture for the Spotted Bear Ranger Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	122
Figure 43.	Energy Release Component for the Gleason's Resort NFDRS Station, near the Lewis and Clark National Forest; seasonal average for 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	124
Figure 44.	Burning Index for the Gleason's Resort NFDRS Station, near the Lewis and Clark National Forest; seasonal average for 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	126
Figure 45.	Thousand Hour Fuel Moisture for the Gleason's Resort NFDRS Station, near the Lewis and Clark National Forest; seasonal average for 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.	127
Figure 46.	Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for July 18 - July 22, 1988 (MST).	152
Figure 47.	Monture RAWS Station air temperature and relative humidity measurements for July 18 - July 22, 1988 (MST).	153

Figures (Continued)

		Page
Figure 48.	Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for July 23 - July 27, 1988 (MST).	162
Figure 49.	Monture RAWS Station air temperature and relative humidity measurements for July 23 - July 27, 1988 (MST).	163
Figure 50.	Detail from the Crown Fire Nomogram (Rothermel 1991) for the July 23, 1988 fire behavior in the Cabin Creek drainage during the Canyon Creek Fire.	164
Figure 51.	Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, and average wind speed measurements for July 24 - July 27, 1988 (MST).	167
Figure 52.	Benchmark RAWS Station air temperature, relative humidity, and average wind speed measurements for July 24 - July 27, 1988 (MST).	168
Figure 53.	Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for July 28 - August 1, 1988 (MST).	179
Figure 54.	Monture RAWS Station air temperature and relative humidity measurements for July 28 - August 1, 1988 (MST).	180
Figure 55.	Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, and average wind speed measurements for July 28 - August 1, 1988 (MST).	181
Figure 56.	Benchmark RAWS Station air temperature, relative humidity, and average wind speed measurements for July 28 - August 1, 1988 (MST).	182
Figure 57.	Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for August 2 - August 6, 1988 (MST).	191
Figure 58.	Monture RAWS Station air temperature and relative humidity measurements for August 2 - August 6, 1988 (MST).	192
Figure 59.	Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, and average wind speed measurements for August 2 - August 6, 1988 (MST).	193
Figure 60.	Benchmark RAWS Station air temperature, relative humidity, and average wind speed measurements for August 2 - August 6, 1988 (MST).	194

Figures (Continued)

		Page
Figure 61.	Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, and precipitation measurements for August 7 - August 11, 1988 (MST).	202
Figure 62.	Monture RAWS Station air temperature, relative humidity, and precipitation measurements for August 7 - August 11, 1988 (MST).	203
Figure 63.	Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for August 7 - August 11, 1988 (MST).	204
Figure 64.	Benchmark RAWS Station air temperature, relative humidity, average wind speed, and maximum gust wind speed measurements for August 7 - August 11, 1988 (MST).	205
Figure 65.	Detail from the Crown Fire Nomogram (Rothermel 1991) for the August 9, 1988 fire behavior in Tobacco Valley during the Canyon Creek Fire.	209
Figure 66.	Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for August 12 - August 16, 1988 (MST).	216
Figure 67.	Monture RAWS Station air temperature and relative humidity measurements for August 12 - August 16, 1988 (MST).	217
Figure 68.	Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and precipitation measurements for August 12 - August 16, 1988 (MST).	218
Figure 69.	Benchmark RAWS Station air temperature, relative humidity, average wind speed, maximum gust wind speed, and precipitation measurements for August 12 - August 16, 1988 (MST).	219
Figure 70.	Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for August 17 - August 21, 1988 (MST).	229
Figure 71.	Monture RAWS Station air temperature, and relative humidity measurements for August 17 - August 21, 1988 (MST).	230
Figure 72.	Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for August 17 - August 21, 1988 (MST).	231

Figures (Continued)

		Page
Figure 73.	Benchmark RAWS Station air temperature, relative humidity, average wind speed, and maximum gust wind speed measurements for August 17 - August 21, 1988 (MST).	232
Figure 74.	Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for August 22 - August 26, 1988 (MST).	244
Figure 75.	Monture RAWS Station air temperature, and relative humidity measurements for August 22 - August 26, 1988 (MST).	245
Figure 76.	Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and precipitation measurements for August 22 - August 26, 1988 (MST).	246
Figure 77.	Benchmark RAWS Station air temperature, relative humidity, average wind speed, maximum gust wind speed, and precipitation measurements for August 22 - August 26, 1988 (MST).	247
Figure 78.	Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for August 27 - August 31, 1988 (MST).	260
Figure 79.	Monture RAWS Station air temperature, and relative humidity measurements for August 27 - August 31, 1988 (MST).	261
Figure 80.	Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for August 27 - August 31, 1988 (MST).	262
Figure 81.	Benchmark RAWS Station air temperature, relative humidity, average wind speed, and maximum gust wind speed measurements for August 27 - August 31, 1988 (MST).	263
Figure 82.	Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for September 1 - September 5, 1988 (MST).	279
Figure 83.	Monture RAWS Station air temperature, relative humidity, average wind speed, and maximum gust wind speed measurements for September 1 - September 5, 1988 (MST).	280
Figure 84.	Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for September 1 - September 5, 1988 (MST).	281

Figures (Continued)

		Page
Figure 85.	Benchmark RAWS Station air temperature, relative humidity, average wind speed, and maximum gust wind speed measurements for September 1 - September 5, 1988 (MST).	282
Figure 86.	Silver King Lookout Station air temperature, relative humidity, and average wind speed measurements for September 3 - September 7, 1988 (MST).	290
Figure 87.	Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and precipitation measurements for September 6 - September 10, 1988 (MST).	304
Figure 88.	Monture RAWS Station air temperature, relative humidity, average wind speed, and maximum gust wind speed, and precipitation measurements for September 6 - September 10, 1988 (MST).	305
Figure 89.	Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and precipitation measurements for September 6 - September 10, 1988 (MST).	306
Figure 90.	Benchmark RAWS Station air temperature, relative humidity, average wind speed, maximum gust wind speed, and precipitation measurements for September 6 - September 10, 1988 (MST).	307
Figure 91.	Spotted Bear Lookout RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for September 6 - September 10, 1988 (MST).	308
Figure 92.	Spotted Bear Lookout RAWS Station air temperature, relative humidity, average wind speed, and maximum gust wind speed measurements for September 6 - September 10, 1988 (MST).	309
Figure 93.	Detail from the Crown Fire Nomogram (Rothermel 1991) for the September 6, 1988 fire behavior in the East Fork of the North Fork of the Blackfoot River and the mountainous terrain to the north during the Canyon Creek Fire.	312
Figure 94.	Detail from the Crown Fire Nomogram (Rothermel 1991) for the September 6, 1988 fire behavior in the drainages north and east of the Dearborn River on the Lewis and Clark National Forest during the Canyon Creek Fire.	314

Figures (Continued)

Page

Figure 95. Spokane International Airport radiosonde data for windspeed and elevation for the time periods of 1800 hrs September 6, 1988 and for 0600 hrs on September 7, 1988. 325

Figure 96. Great Falls International Airport radiosonde data for windspeed and elevation for the time periods of 1800 hrs September 6, 1988 and for 0600 hrs on September 7, 1988. 326

Figure 97. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and precipitation measurements for September 11 - September 15, 1988 (MST). 355

Figure 98. Monture RAWS Station air temperature, relative humidity, average wind speed, maximum gust wind speed, and precipitation measurements for September 11 - September 15, 1988 (MST). 356

Figure 99. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and precipitation measurements for September 11 - September 15, 1988 (MST). 357

Figure 100. Benchmark RAWS Station air temperature, relative humidity, average wind speed, maximum gust wind speed, and precipitation measurements for September 11 - September 15, 1988 (MST). 358

Section 1.0.0 Scapegoat Wilderness Area Topography

The Scapegoat Wilderness is a area of rugged landscape situated in northwestern Montana. The area designated for wilderness management includes the 74,800 acre Blackfoot Unit, the 80,700 acre Lincoln Unit, and the 80,600 acre Halfmoon Unit; a total of 236,100 acres. Another 31,600 acres are designated for RARE II evaluation (USDA 1981). The Scapegoat Wilderness is the southern most portion of the geographic area commonly referred to as the Bob Marshall Wilderness complex. The wilderness complex includes the additional Bob Marshall and Great Bear Wilderness areas further to the north.

Mountains within the wilderness and the adjacent eastern Rocky Mountain Front Range country are commonly considered part of the Sawtooth Range, and are a portion of the Overthrust Belt. The mountains are mostly limestone fault scarps. The front range is considered by many to be the most impressive physical feature within Montana with scarps abruptly rising up to 1,000 ft from the adjacent plains. Elevation within the Scapegoat Wilderness ranges from approximately 4,500 ft msl at the lowest portion of the North Fork of the Blackfoot River to about 9,202 ft msl at the top of Scapegoat Mountain. Most mountain peaks in the area are generally between 7,500 and 8,800 ft msl with forested timberline being at approximately 7,800 ft msl.

A portion of the Continental Divide forms the backbone of the wilderness area and is located in the eastern third of the wilderness. Many of the peaks which form the Continental Divide within the Scapegoat Wilderness are just barely above timberline with lower swales, saddles and passes in most cases below the upper reaches of the coniferous forest. These relatively low lying, high elevation sites provide generally unrestricted freedom to potential fire spread when the areas are covered by forest. The largest unvegetated areas are the peaks and ridges associated with the Scapegoat Mountain limestone massif (including 9,079 ft msl Flint Mountain, 8,523 ft msl Observation Point, and 8,523 ft msl Triple Divide), Crow Mountain (8,611 ft msl), and Caribou Peak (8,775 ft msl). These areas successfully inhibited fire spread by the Canyon Creek Fire in 1988. The area to the east of Crow Peak, and including a relatively large portion of the Dearborn drainage, remained unburned during both the 1889 and 1988 fire seasons when most of the southern portion of the Scapegoat Wilderness area burned. This was the result of a generally westerly fire spread with the prevailing winds which split to either side, north and south, of Crow Peak and it's associated barren ridge tops. Caribou Peak and associated ridge lines successfully prevented additional southern spread of the Canyon Creek Fire in it's vicinity. The Scapegoat Mountain area restricted northern spread of the Canyon Creek Fire for 46 days while the fire maneuvered around the southeastern corner. Similar blockage of fire by Scapegoat Mountain is indicated from mapping done of the 1889 fire in the same vicinity (Ayres 1901).

The North Fork of the Blackfoot River drains the western portion of the Scapegoat Wilderness and flows in a generally southerly direction. The North Fork of the Blackfoot has two principal side drainages besides the North Fork; the Dry Fork which flows from the northwest, and the East Fork which flows from the divide west. Many of the lesser tributaries which flow into these principal forks of the river tend to be oriented in a general east - west orientation on the west side of the Continental Divide.

On the east side of the divide the landscape is drained by several small creeks which for the most part run in a east - southeasterly direction and merge with the Dearborn River which in turn, after leaving behind the Rocky Mountain Front and entering the prairies, flows into the Missouri River.

Further north in the Scapegoat and still on the east side of the divide, several drainages flow to the northwest and empty in to the Sun River.

Section 2.0.0 Fire History and Forest Succession

The current interrelated roles of fire and forest succession in the Scapegoat Wilderness is a culmination from previous fire history and biomass accumulation and decomposition within the area. The known (and speculated) fire history of the Scapegoat Wilderness and adjacent areas is integrated with information on fire effects of the important tree species and forest fuel to describe the role of fire in shaping the vegetative composition.

The vegetative composition and generalized forest succession of differing forest habitat types (Pfister and others 1977) have been classified into Fire Groups which tend to respond to fire in a similar manner (Davis and others 1980). The exception is Fire Group Zero which is a collection of heterogeneous habitats, which for the most part lack a forest component. This section is mainly a review of the literature covering fire ecology in the appropriate Fire Groups contained in the Scapegoat Wilderness (Davis and others 1980, Fischer and Clayton 1983, Fischer and Bradley 1987). Physical descriptions of the climate and geological features for the fire groups in the Scapegoat Wilderness are from Pfister and others (1977), and USDA (1980).

Three levels of fire severity are used, and these are closely connected to the fire intensity or amount of heat produced by a fire and the resultant impact on the associated vegetation. A low severity, or cool fire, is one which causes a minimal amount of impact to a site. This type of fire burns through the surface fuel and generally only consumes the litter, herbaceous fuel, and the foliage and small twigs on woody undergrowth. Very little heat travels downward through the duff layer beneath the litter. The duff and litter layers may appear charred on the surface but are essentially unaltered over their entire depth. Woody debris is partially burned and logs are blackened but not charred. Low severity fires are also generally low in intensity as well, exceptions occur such as high severity-low intensity fires in scree or deep organic soils. These fires tend to fall in the range of 1 to 3 ft flame lengths and release energy of approximately 5 to 50 BTU's/Ft/Sec. A moderate fire also burns in surface fuel but may also involve the tree understory. This fire consumes the litter, upper duff, understory plants, and foliage on understory trees. Following the fire the ground is covered with a light-colored ash and char which, except for large particles, tends to disappear the following growing season. Woody debris is largely consumed and logs are deeply charred. Individual and groups of overstory trees may experience either crown scorch from the fire on the surface, or torch out (actively carry fire into the tree crown) if sufficient ladder fuel exists. Fire of this nature frequently fall within a flame length of 4 to 11 ft and a fireline intensity of 100 to 1,000 BTU's/Ft/Sec. A severe fire burns through the forest overstory and consumes large woody surface fuel and/or removes the entire duff layer over much of the area. Heat from the fire can impact the upper soil layer consuming some of the incorporated soil organic matter altering the soil color and in scattered patches under heavier concentrations of fuel turning the soil reddish (Fischer and Clayton 1983, Ryan and Noste 1985). Fires with flame lengths of approximately 11 ft start to exhibit crowning fire behavior when sufficient fuel conditions exist. Spot fires from burning embers may be carried a short distance of several hundred feet. With increasingly severe burning conditions flame lengths lengthen and fireline intensities climb. Long distance spotting increases up to 10 to 12 miles, crown fire rates-of-spread have been seen of 6,000 to 36,000 ft/hr (1,829 to 10,973 m/hr), and fireline intensities of 1,000 to 22,500 BTU's/Ft/Sec (Anderson 1968).

Section 2.1.0 Relationship of Major Tree Species to Fire

Wildfire has played a major role in forest succession throughout the Northern Rocky Mountains, including those forests and forested grasslands within the Scapegoat Wilderness in Montana. Lodgepole pine, for example, owes its present widespread occurrence to past fire. Without fire Douglas-fir would dominate areas where ponderosa pine now occurs but is not climax. Similarly, Doulgas-fir occupies many sites where it is not climax because of past fire. Periodic fire allows western larch to persist on many sites where it is not climax. Fire has favored the distribution of Engelmann spruce at the expense of subalpine fire (Wellner 1970).

Fire may or may not favor a particular tree species depending on certain physical characteristics of the species and its regeneration strategy. Physical characteristics determine a species susceptibility or resistance to fire damage. Regeneration strategy determines whether a species continued presence on a site is enhanced or curtailed by fire.

Section 2.1.1 Limber Pine (*Pinus flexilis*), (PIFL)

The degree of stem scorch usually determines the extent of fire injury to limber pines. Young trees are usually killed by any fire that scorches their stems. The bark of young limber pine is too thin to prevent cambium injury, even from a cool fire. Older trees are better able to withstand stem scorch from low severity fires because the bark around the base of mature trees is often 2 inches thick. The needles of limber pine form into tight clusters around the terminal buds. This shields the buds from heat associated with crown scorch.

Keown (1977) conducted prescribed fire studies in dry limber pine habitat types in the central forest region of Montana (Lewis and Clark National Forest). The study results indicate a strong relationship between fuel type, fire severity, and fire injury to limber pine. On sites where grass was the primary fuel and where trees were present as scattered individuals or open stands, fire severity was low and limber pine mortality was light (about 20 percent) even though basal limbs commonly extended to the ground. In similar situations but with a dense understory of shrubs rather than a grass understory, fire severity was high and limber pine mortality often reached 80 percent. The final situation reported by Keown (1977) was where a closed canopy forest bordered grassland or shrubland. Trees in these transition zones were often less than 10 ft tall with lower branches intermingled with ground fuel. The most severe fires in Keown's study occurred on these sites.

The last two situations were also observed by a naturalist surveying the Rocky Mountain Front Range at the turn of the century. Aryes (1901) observations took place 10 years after a major fire had burned most of the Front Range on what is now mostly either private lands or portions of the Lewis and Clark National Forest to the east of the Scapegoat Wilderness.

> "The extensive, almost continuous burns on the foothills once partially covered with limber pine have not been restocked and so far as covered with vegetation have only weeds and brush if recent, or bear grass and scant forage plants if old. The principal bushes are willow and aspen. Young trees of limber pine are found on the half barren knolls that reach out into the plains and on the recently burned and severely

burned lands. The condition of the burned land is most desolate. Only about 6 per cent of it is restocked and the remainder bristling with deadwood, standing or fallen, sometimes has no plants growing upon it, especially if high in altitude or dry".

Frequently the bunchgrasses growing with limber pine are shaded out by dense stands of this species frequently in association with Douglas-fir, or partially buried in pine needle litter. After a severe fire has removed both the overstory and the pine litter little herbaceous vegetation is left to immediately vegetate the area formerly occupied by the trees. This in part explains the "desolate" character off the land Ayers traveled through. He also tended to interpret what he saw from the view point of a Forester interested in timber resources. The young trees that Ayers commented on as occupying "barren knolls" were probably areas protected from the fires by either rock outcrops or exposed bare soils where fuel was light.

There is no evidence to suggest that fire is necessary to prepare seedbeds for limber pine. Many limber pine habitats are characterized by scattered patches of bare soil. Some sites are heavily covered by bunchgrasses. Limber pine readily encroaches upon sites occupied by grass and shrubs. Limber pine has also been observed becoming established in mats of common juniper (Juniperus communis) which had burned more than 60 years previously. Limber pine has large, wingless seeds incapable of wind dispersal. A study by Lanner and Vander Wall (1980) indicates that limber pine regeneration on burns is largely a result of seeds planted by Clark's nutcrackers (Nucifraga columbiana). These birds store limber pine seed in the soil for food. No other reliable dispersal agent of limber pine has been identified.

Limber pine occurs primarily in Fire Group One but is also present as a minor species in Fire Groups Six and Eight. The species is generally a forest component of either high elevation, or dry sites east of the Continental Divide.

Section 2.1.2 **Ponderosa Pine (Pinus ponderosa), (PIPO)**

Ponderosa pine has many fire-resistant characteristics. Seedlings and saplings are often able to withstand relatively high temperatures, whether from a light surface fire during dormancy or from the severe thermal stress inherent in becoming established on hot, dry exposures. Development of insulative bark and the tendency for meristems to be shielded by enclosing needles and thick bud scales, contributes to the temperature resistance of pole-sized and larger trees.

Propagation of fire into the crown of pole-sized and larger trees growing in relatively open stands (dry sites) is unusual because of three factors. First, the thick bark is relatively unburnable and does not easily carry fire up the bole or support residual burning. Resin accumulations, however, make the bark more flammable. Second, the tendency of ponderosa pine to self-prune lower branches keeps the foliage separated from burning surface fuel. Third, the open, loosely arranged foliage does not lend itself to combustion or the propagation of flames.

On moist sites, ponderosa pine often forms two-storied stands that may be quite susceptible to crown fire. The tendency for regeneration to form dense understories, or "dog-hair" thickets, on such sites creates fuel ladders that can carry ground fires to the crowns of overstory trees. Crown fires are,

consequently, more frequent on moist sites than they are on dry sites. Understory pondersoa pine may also be more susceptible to fire damage because crowded conditions can result in slower diameter growth. Such trees do not develop their protective layer of insulative bark as early as would otherwise be expected. They remain vulnerable to cambium damage from ground fires longer than their counterparts in open stands. The thick, overcrowded foliage of young stands or thickets also negates the fire-resisting characteristics of open, discontinuous crown foliage normally found in this species. The thinning effect of fire is therefore much more pronounced in dense stands than it is in open stands.

Ponderosa pine seedling establishment is favored when fire removes the forest floor litter and grass and exposes mineral soil. Fire resistance of the open, parklike stands is enhanced by variable light fuel quantities. Heavy accumulations of litter at the base of trunks increases the intensity and duration of fire, often resulting in a fire scar or "cat face". Flammable resin deposits around wounds can make the tree susceptible to fire damage and usually cause an enlargement of the scar with subsequent fires.

Ponderosa pine is among the most fire resistant tree growing in Montana, it has a competitive advantage over most other species when mixed stands burn. Ponderosa pine occurs primarily in Fire Groups One, Two, Three and Four. Only Groups Two and Four are found in the vicinity of the Scapegoat Wilderness. Ponderosa pine is restricted for the most part to the lower elevation mountain valleys where it is either seral to Douglas-fir or grows in mountain grasslands to dry for most other tree species.

Section 2.1.3 Douglas-fir (Pseudotsuga mengziesii), (PSME)

Mature Douglas-fir is a moderately fire-resistant tree; saplings, however, are vulnerable to surface fires because of their thin, photosynthetically active bark, resin blisters, closely spaced flammable needles, and thin twigs and bud scales. The moderately low and dense branching habit of saplings enables surface fires to be carried into the crown layer. Older trees develop a relatively unburnable, thick layer of insulative corky bark that provides protection against cool to moderately severe fires, but this protection is often offset by a tendency to have branches the length of the bole. The development of "gum cracks" in the lower trunk that streak the bark with resin, can provide a mechanism for serious fire injury.

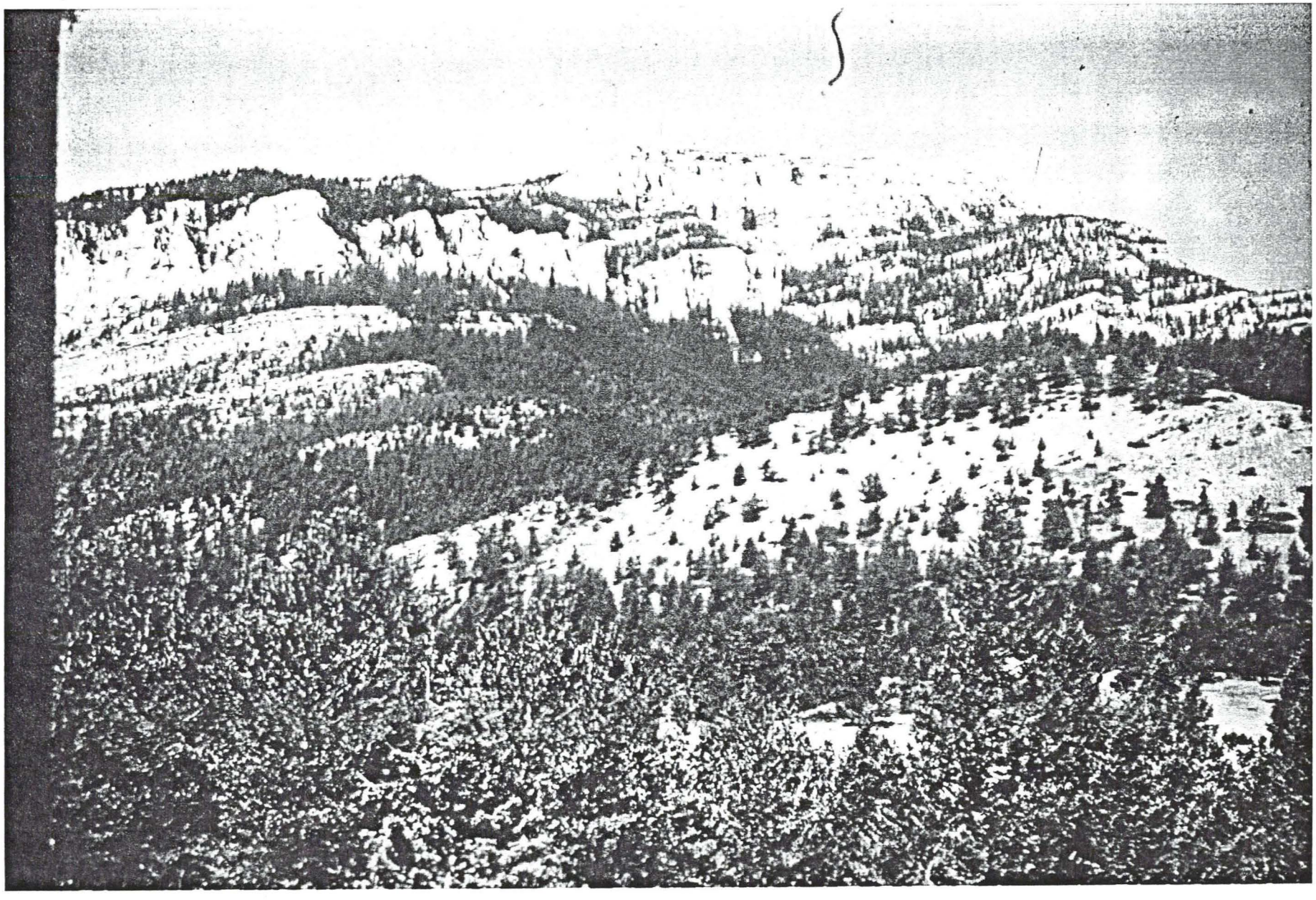
Douglas-fir does occur in open-grown stands, but it also grows in denser stands with continuous fuel underneath. Dense sapling thickets can form an almost continuous layer of flammable foliage about 10 to 26 ft above the ground that will support wind-driven crown fires. Even small thickets of saplings provide a route by which fire can reach the crowns of mature trees. Gruell (1983) found that some of the forest east of the Continental Divide which was occupied principally by Douglas-fir with limber pine as an associate (Fire Groups Five and Six) had regenerated into denser stands after a severe fire had burned the original stand. These same forests, visited and rephotographed by Gruell, showed the impact of the 1889 fire in that area and were later reburned by the 1988 Canyon Creek Fire (figures 1 - 2).

As with ponderosa pine, heavy fuel accumulation at the base of the tree increases the probability of fire injury. Also, resin deposits usually enlarge old scars during subsequent fires.

Douglas-fir regeneration is favored by fire, which reduces vegetative cover and exposes mineral soil so shallow taproots of seedlings can take hold.

Figure 1. Steamboat Mountain; July 10, 1921 by W. C. Alden (Gruell, 1983; Plate 26a). This photograph shows Fire Group Five, cool - dry Douglas-fir at an elevation of 5,000 ft msl. The view is looking northwest across the Dearborn river toward Steamboat Mountain from a point approximately 2.5 miles west of what is now the Diamond X Ranch. The vegetation on near slope and in distance is in early succession following the 1889 fires. Conifers surviving these fires were confined to moist sites and rocky areas where fuel was sparse.

Figure 2. Steamboat Mountain; September 7, 1981 by R. F. Wall (Gruell, 1983; Plate 26b). This photograph shows Fire Group Five, cool - dry Douglas-fir at an elevation of 5,000 ft msl 60 years after the previous view. The camera was moved back from the original location to avoid Douglas-fir and limber pine that screened original view. Scene shows a marked change in tree cover on the deeper soils. Conifer establishment has been slow on the harsh (rocky and dry) sites. The 1988 Canyon Creek Fire failed to burn most of this particular view, but did reburn the north and northeast aspects of Steamboat Mountain on the upper right hand side to about the center of the mountain face, and behind the mountain.



Douglas-fir is, however, better able than its competitors to regenerate on unburned sites.

Douglas-fir occurs in Fire Groups One, Four, Five, Six, Seven, Eight, and Nine.

Section 2.1.4 Engelmann spruce (Picea engelmannii), (PIEN)

Engelmann spruce, including hybrids with white spruce (Picea glauca)(Habeck and Weaver 1969), is easily killed by fire. The dead, dry, flammable lower branches, low-growing canopy, thin bark, and lichen growth in the branches contributes to the species vulnerability. The shallow root system is readily subject to injury from fire burning through the duff. Older trees that have deep accumulations of resinous needle litter around their bases are particular susceptible. Trees that do survive fire are often subjected to successful attack by wood-destroying fungi that easily enter through fire scars. The high susceptibility of spruce to fire damage is mitigated in part by the generally cool and moist habitats where it grows.

Spruce is not an aggressive pioneer. It is a moderate seeder, but seed viability is rated good and the vitality persistent (Alexander and Sheppard 1984). Seedlings can survive on a wide variety of seedbeds. Initial establishment and early growth of seedlings may be slow, but usually good when encouraged by shade and abundant moisture. Spruce seedlings will occur as members of a fire-initiated stand with lodgepole. Spruce's shade tolerance allows it to establish and grow beneath a lodgepole pine canopy. On sites where it is the indicated climax species, spruce will eventually dominate the stand, but it takes a long period without fire before this situation can occur.

Restocking will occur more quickly if some spruce trees survive within the burn than if regeneration is dependent on seed from trees at the fire edge. Pockets of spruce regeneration often become established around such surviving seed trees up to a distance of 300 ft, the effective seeding distance for spruce. Successful regeneration diminishes 100 to 150 years after establishment due to insufficient sunlight at ground level and to accumulating duff. At this point, the more tolerant subalpine fir begins to successfully regenerate.

Engelmann spruce occurs primarily in Fire Groups Five, Seven, Eight, Nine and Ten.

Section 2.1.5 Lodgepole Pine (Pinus Contorta), (PICO)

Individual mature lodgepole pine trees are moderately resistant to surface fires. Lodgepole's thin bark makes it susceptible to death from cambium heating. Lodgepole pine stands alone, however, in its ability to perpetuate itself on a site despite fire. Indeed, on most sites where lodgepole grows, fire is necessary for the species continued dominance.

Lodgepole pine's key fire survival attribute is cone serotiny. Although there are exceptions, most lodgepole stands in Montana are composed of trees containing both serotinous and nonserotinous or open cones. The ratio of serotinous and nonserotinous cones seems to be related to the fire frequency for the site: the higher the fire frequency the greater proportion of serotinous cones and vice versa (Perry and Lotan 1979).

A temperature of 113 degrees F (45 degrees C) is usually required to melt the resin that binds the scales of a serotinous cone. Heat from a fire is about the only way such temperatures will occur in the crown of a standing

lodgepole pine. Large quantities of highly viable seed are therefore available to regenerate a site following a stand-destroying fire.

Aside from serotinous cones, other silvical characteristics (USDA Forest Service 1965) that contribute to lodgepole pine's success in dominating a site following fire are:

1. Early seed production. Cones bearing viable seed are produced by trees as young as 5 years in open stands and by trees 15 to 20 years old in more heavily stocked stands. This feature not only allows relatively young stands to regenerate a site following fire, but also the seed from open cones can fill in voids left by the original postfire seeding from serotinous cones. Should the site reburn the seed produced in the serotinous cones of the young regeneration are available to again reestablish the lodgepole pine. The resultant reburnt stands usually have an even greater proportion of lodgepole pine to other conifer species due to these other species susceptibility to fire caused mortality at a young age, their inability to reproduce at such an early age, and their lack of serotiny.
2. Prolific seed production. Good cone crops occur at 1- to 3-year intervals with light crops intervening.
3. High seed viability. Seed in 80-year-old serotinous cones have been found to be viable.
4. High survival and rapid growth. High seedling survival and early rapid growth are characteristic of lodgepole pine, especially on mineral soil seedbeds exposed to full sunlight.

Lodgepole pine's success in regenerating a site following fire often results in dense, overstocked stands. Such stands are susceptible to stagnation, snow breakage, windthrow, dwarf mistletoe (Arceuthobium americanum) infestation, and mountain pine beetle (Dendroctonus ponderosae) attack. The combined effect of these factors is extreme buildup of downed, dead woody fuel on the forest floor. Thus, the stage is set for another stand-destroying wildfire.

Lodgepole pine occurs primarily in Fire Groups Six, Seven, Eight, and Nine.

Section 2.1.6 Western Larch (Larix occidentalis), (LAOC)

Western larch is the most fire resistant conifer in the Northern Rocky Mountains. It possesses an insulating bark that can, in mature trees, range from 3 to 6 inches thick. The fire resistance of western larch is enhanced by its tendency to self-prune lower branches and its tolerance of defoliation. Western larch is a deciduous conifer and replaces its needles annually. Defoliation by fire is less traumatic for larch than for conifers that normally replace their needles at 2- or 3-year intervals.

Western larch can become established rapidly on mineral soil exposed by fire. Its lightweight seed can be blown from considerable distances to potential germination sites. A highly intolerant species, western larch requires full or near-full sun for best development. Lodgepole pine and larch are both potential seral dominants on many sites. Western larch is a better competitor where there is higher soil moisture.

Western larch is long lived. Old fire-scarred tree stumps in the Seeley Lake valley west of the Scapegoat Wilderness indicate ages in excess of 900 years at the time of cutting. Such longevity helps maintain larch as a stand component and potential seed source for many years.

Western larch can occur in Fire Groups Six through Ten in the vicinity of the Scapegoat Wilderness.

Section 2.1.7 Subalpine Fir (Abies lasiocarpa), (ABLA)

Subalpine fir is rated as the least fire-resistant Northern Rocky Mountain conifer because of its thin bark, resin blisters, low and dense branching habit, and moderate-to-high stand density in mature forests. As a result, fire most often acts as a stand-replacement agent when it burns through a subalpine fir forest. Even relatively cool ground fires can cook the cambium or spread into the ground-hugging branches and from there up into the crown.

Subalpine fir may begin producing seed when only 20 years old, but maximum seed production is by dominant trees 150 to 200 years old. Subalpine fir has the ability to germinate and survive on a fairly wide range of seedbeds.

Subalpine fir can occur in a fire-initiated stand with Douglas-fir, lodgepole pine, and other seral species because it germinates successfully on a fire-prepared seedbed. But subalpine fir usually remains a slower growing, minor component dominated by less tolerant species.

Subalpine fir can better exist under low light conditions than most associated species. But Engelmann spruce will often grow faster than subalpine fir where light intensity exceeds 50 percent of full sunlight. Subalpine fir is shade tolerant and is the indicated climax species on many sites containing lodgepole pine. Where a good seed source exists, the fir will invade and grow in the understory of lodgepole stands. Given a long enough fire-free period, subalpine fir will overtop lodgepole pine on sites where it is the indicated climax.

Subalpine fir occurs in Fire Groups Seven through Ten.

Section 2.1.8 Subalpine Larch (Larix lyallii) (LALY)

Subalpine larch is a thin-barked species easily damaged by fire. However, it is moderately fire-resistent primarily because of its stand habit. It grows only on the highest elevations inhabiting extremely rocky and generally moist and cold sites. Alpine larch can grow in pure groves, in small groups, or as isolated individuals. In the lower portion of its elevational distribution, it occurs with subalpine fir, Engelmann spruce, and whitebark pine.

In the timberline zone, fire is a cause of tree mortality but is less frequent and widespread than in contiguous forests below. Severe fires may enter the subalpine larch stands from lower forests. However, they do not always adversely affect subalpine larch stands. For example, northern Idaho's severe Sundance Fire of 1967 swept the ridges of Roman Nose Mountain killing much of the spruce, fir, and whitebark pine in the cirques, but causing only minor damage to isolated stands of subalpine larch (Arno 1970). Sparse vegetation and rocky slopes curtail the intensity of fire in these areas.

When subalpine larch grows in association with a vigorous stand of subalpine fir, Engelmann spruce, and whitebark pine, it is an intolerant species that dies out when overtopped by other conifers. Arno (1970) stated that fire allowed subalpine larch to remain a major forest component with these species in some areas.

Subalpine larch grows in Fire Group Ten.

Section 2.1.9 Whitebark Pine (Pinus albicaulis), (PIAL)

Whitebark pine is a semitolerant or midtolerant species that has been observed as a pioneer inhabiting species recently burned sites. It occurs as the potential climax species on alpine timberline and exceptionally dry sites but is seral in upper subalpine forests (Arno 1986). Whitebark pine is

moderately fire resistant. It has a relatively thin bark and is susceptible to fire injury from hot surface fires that heat the tree's cambium. The characteristically dry, exposed site and open stand structure tend to reduce whitebark pine's vulnerability to fire. The fact that whitebark pine often reaches ages of 500 years or more reflects the reduced fire threat.

Near its lower elevational limit, whitebark pine may occur in small groups with lodgepole pine, subalpine fir, and Engelmann spruce. However, the general impression of whitebark pine communities is that of open stands where the undergrowth is predominately continuous low shrubs, forbs, and grasses. Occasionally larger shrubs and stunted trees are present.

Fires that burn in the undergrowth are usually of low-to-moderate severity. But the low, ground-hugging crowns of associated conifers can provide a fuel ladder, and downfall in the vicinity of mature trees locally increases crown fire potential. Hence, severe fire is possible.

Severe wildfires starting in lower elevations can spread throughout the upper elevation forests to timberline. Although the open nature of a whitebark pine forest acts as a firebreak, many trees can be killed under these conditions. The most common fires are high elevation lightning fires that do not spread far. However, during extended dry periods of high fire danger, these usually benign fires may spread downhill into dense lower elevation forests.

Whitebark pine has a large, wingless seed that does not disperse by wind. Regeneration on burned sites is usually the result of seed germination from bird and rodent seed caches, especially those of Clark's nutcracker (Hutchins and Lanner 1982).

Whitebark pine occurs in Fire Groups Six, Eight, Nine, and Ten.

Section 2.2.0 FIRE GROUP ZERO: MISCELLANEOUS SPECIAL HABITATS

The scree and forested rock portions of Fire Group Zero make up approximately 35% of the area within the Scapegoat Wilderness and adjacent Dahaher portion of the Bob Marshall Wilderness. Wet meadows and mountain grasslands make up less than one percent of the area (USDA 1981). Aspen groves and alder glades are represented by minor inclusions. Aspen groves increase in importance outside the Scapegoat Wilderess on the east side of the Continental Divide.

Section 2.2.1 Scree

Scree refers to slopes covered with loose rock fragments, usually lying near the maximum possible angle of repose so that any disturbance causes minor rock slides down the face of the slope. Normally scree occurs on steep to very steep peaks, glacial cirque headwalls, glacial trough walls and fault escarpments with slopes averaging between 55-70 percent. Scree slopes may be treeless or they may support scattered trees with sparse undergrowth. Usually scree communities are regarded as special environments where the vegetation is in an uneasy equilibrium with the unstable substrate. Scree in the Scapegoat Wilderness is a common environment, though not necessarily great in extent, associated with the steep sides of the mountains and may occur at any elevation.

The trees most commonly associated with scree in, and near, the Scapegoat Wilderness at lower elevations include limber pine, Rocky Mountain juniper, and Douglas-fir. At higher elevations, where scree is a major component, these

habitats are occupied by lodgepole pine, Engelmann spruce, subalpine fir, or whitebark pine.

The discontinuous fuel often makes scree slopes unburnable with low severity or moderate fires. Even in a severe fire only individual trees or islands of vegetation may ignite, but fire spread is usually limited by the potential spotting distance of torching conifers. Under very dry conditions organic fuel which has blown or fallen on to the scree and accumulated over the years in the rock along with moss and lichen growth have proven to be capable of sustaining fire spread. The resultant low intensity, but high severity fire, follows the available fuel and can cross the scree into more continuous fuel types. A severe wind-driven fire could pass over the intervening open spaces and burn a scree community, but this rarely happens. Due to the harsh environment, these sites do not revegetate well, and revegetation following a fire is slow. Frequently a period greater than 60 years is necessary to reestablish tree species.

Section 2.2.2 **Forested Rock**

Forested rock is usually a steep canyon wall or mountain composed of rock outcrops, cliffs, and occasional clumps of trees clinging to ledges and crevices. Forested rock is especially prominent along canyons of the major rivers and in rugged upper subalpine areas near timberline where it can be found associated with glacial cirques headwalls, valley troughs, and fault escarpments. These sites contain a certain similarity to scree, but the substrate is solid and climax species frequently become established. This environment is common but generally small in size within the Scapegoat Wilderness. Species growing here include ponderosa pine, Douglas-fir, juniper, and alder at lower elevations; and all seral or climax species which occur at the higher elevations.

Surface fires do not burn well in forested rock communities because of the vertical and horizontal discontinuity of ground fuels. The probability of crown fires depends on the density and arrangement of trees on the rock face. In some cases the islands of vegetation are so widely scattered as to be almost immune to wildfire. In other cases, particularly low elevation Douglas-fir forested rock communities, a continuity of foliage from the base to the top of a cliff can occur. Each tree forms a ladder into the lower branches of the next higher tree upslope. In such cases crown fires can occur over ground that would not support a less severe surface fire.

Revegetation of rocky sites proceeds at a rate characteristic of the site and depends on the severity of the fire, the age and depth of the soil on ledges and pockets of rock, erosion if any, available moisture, and the availability of seeds or resprouting rootstock.

Section 2.2.3 **Wet, Grass-Sedge Meadow**

A meadow is an opening in the forest that is characterized by herbaceous vegetation and abundant water. These sites are typically wet, lowland areas on alluvial bottoms of 3rd to 6th order streams or old lake basins within the Scapegoat Wilderness. Elevations range from 4,500 to 5,200 ft msl. Precipitation ranges from 25 to 35 inches a year with about 40 percent coming as snow. Subirrigation is common during at least part of the growing season. Mountain meadows are frequently too wet to burn during the fire season. In midsummer, wet meadows often act as fire breaks, but during the late summer and early fall they may carry grass and sedge fires. In some situations,

especially when meadows are dominated by grass, they may burn early in the spring following snowmelt and prior to greenup.

Streamside meadows may gradually become drier in the course of succession from a hydric to a mesic condition. The buildup of organic material and trapped sediments from the flowing water, combined with a possible deepening of the streambed and lowering of the water table, can leave former meadows in an intermediate condition between wet meadow and grassland. In such sites the meadow becomes bordered by fire maintained grassland. Fire suppression has allowed conifers to invade drier sites within meadows where they would not normally be found, and for some wet meadows to become shrub carr dominated by thick growths of willow and alder.

Regeneration following fire is rapid on most sites, with forest vegetation on those areas capable of supporting trees appearing in less than forty years.

Section 2.2.4 Mountain Grassland

A mountain grassland (or grassy bald) is a grass-covered opening within an otherwise continuous coniferous forest. These areas occupy level to gently sloping stream terraces, or steep (25-60 percent slope) smooth residual slopes on south or west aspects. Elevations range from 4,800 to 6,800 ft msl. Annual precipitation can range from 20 inches east of the Continental Divide up to 60 inches on the west side. Mountain grasslands may act as firebreaks during the active growing season, but become capable of sustaining fire when the grasses become dormant and cure. Their fire frequency in most cases is the same as the surrounding coniferous forest, but they may not necessarily depend upon fire to maintain their community integrity. Despain (1973) found boundaries between grassland and forest in the Bighorn Mountains of Wyoming, which he attributed to topography and soils. Daubenmire (1943) suggested that soil factors might cause permanent mountain grasslands. Grasslands may also reflect differences in underlying geological structures that influence soil moisture retention making tree establishment difficult. It is possible that some of these mountain grasslands have little potential for forest development. Other grasslands have clear evidence that they are fire maintained and under fire suppression are gradually being encroached upon by the adjacent forest (Arno and Gruell 1986, Gruel and others 1986). Billings and Mark (1957) thought that grassy balds were caused by severe fires that kill all the trees in a stand that happens to lie at the ecotonal limits of a tree species. Following the fire the new environment is too severe to permit regeneration of tree species except under unusual circumstances and is a slow process. It is often hard to tell between what may be a natural grassland or unregenerated old burns because of the length of time necessary for tree invasion. Slight changes in climate that increase available moisture may hasten the process. Climatic trends toward increased drought, reoccurring fires, or outbreaks of insect or disease attacks may slow the potential for encroachment allowing the mountain grassland to exist in a seemingly unchanged state. Short growing seasons due to snow accumulation on some sites will also retard encroachment.

Section 2.2.5 Aspen Grove

Groves of quaking aspen; or quaking aspen, black cottonwood, and willlows can occur as local climax vegetation on streamside or seepage sites or as fire-maintained stands in areas that would otherwise be dominated by conifers. Generally these are located on 3rd to 6th order streams, and between 4,500 to 5,500 ft msl elevation. Annual precipitation is 25 to 35 inches with between

40 and 60 percent as snow. In the fire-maintained areas, the absence of fire can result in the gradual elimination of aspen due to lack of successful regeneration.

Section 2.2.6 **Alder Glade**

An alder glade is an opening in the forest, or within an avalanche chute occupied by alder. Such sites usually appear on localized areas that are too wet for associated conifers, or in the case of avalanche chutes to frequently disturbed, and are most often adjacent to streams or seepage areas. Because they are wet and/or surrounded by scree, alder glades burn infrequently, but they can burn intensely and then resprout from surviving underground stems. Burning tends to make the glade more dense because each burned plant puts up several new shoots during recovery. The glade may also expand into adjacent burned moist areas formerly occupied by conifers until new trees are able to overtop and gradually replace the alders. Alder, like aspen, can exist as a fire-maintained stand in areas where conifer invasion is possible.

Alder within avalanche chutes can be found on very steep, north facing, generally densely forested glacial valley trough walls with 60 to 80 percent slope. These areas occur in the Scapegoat Wilderness between 5,500 to 7,500 ft msl elevation and receive between 25 to 60 inches of annual precipitation. Streams with alder can be found down to the lowest forested elevations within the wilderness and adjacent areas.

Section 2.3.0 FIRE GROUP ONE: DRY LIMBER PINE HABITAT TYPES

Group One habitat types occupy some of the driest sites capable of supporting trees. Stands are dominated by limber pine, which is often the only tree present. Adjacent drier sites are grasslands, while cooler, more moist exposures often support the Douglas-fir habitat types. Douglas-fir may occur as a codominant or subordinate species in some stands. Where it does occur on Group One sites Douglas-fir is often slow growing and of short, or stunted stature. These characteristics make it more susceptible to fire damage than it is on most other sites. Ponderosa pine and Rocky Mountain juniper may occur as minor stand components in some areas. Rarely, whitebark pine is a minor climax associate in higher elevations stands. Lodgepole pine and spruce may occur as accidentals. Fire Group One is predominately to the east of the Scapegoat Wilderness in the ecotonal zones between forest and grassland. It is inclusive in the more common Fire Group Five in that area.

Section 2.3.1 **Forest Fuel**

Downed, dead, woody fuel loads range between 5 tons/acre and 15 tons/acre in Group One stands. About 80 percent or more of the downed woody fuel is usually 3 inches in diameter or larger, regardless of the total fuel load. This material is often the result of the falling of snags created by a previous fire. Downed, dead, woody fuel rarely create a serious fire hazard in this group because loadings are usually light and the material is usually scattered about the site. Where hazardous fuel conditions exist, they are often the result of dead herbaceous fuel.

Section 2.3.2 Role of Fire

Reported fire frequencies for Fire Group One habitats are low. The meager evidence suggests that fires hot enough to scar trees occurred 50 to 100 years apart. Arno and Gruell (1983) investigated a limber pine/bluebunch wheatgrass stand in southwestern Montana that showed evidence of five fires, the earliest in 1588 and the latest in 1877, for a mean fire interval of 74 years. Pfister and others (1977) sampled 100- to 200-year old stands in which there was no apparent sign of fire. The available information does not consistently differentiate between the more severe sites where fuel are light and discontinuous, and the more productive sites where more frequent fire might be expected. Keown's (1977) study was, however, on a productive site, and he reported a fire frequency of 100 years.

Limber pine invasion of adjacent seral grass and shrublands is a slow process because these sites are so dry. The fire susceptibility of young limber pine and Douglas-fir would seem to preclude successful invasion of sites that experience normal grassland fire frequencies of 5 to 25 years (see Fire Groups Two and Four). It is, however, conceivable that successful invasion could occur under a frequent fire regime if those fires were always of low intensity. As noted earlier, Keowns (1977) light fires only killed 20 percent of the encroaching limber pines, while his high intensity fires killed 80 percent.

Frequent cool, surface fires could actually favor development of limber pine stands by keeping fuel from reaching levels that would support severe tree-killing fires. The possibility that Group One sites have been subjected to frequent fires that produce very slight effects (no scarring) cannot be ruled out. The existing evidence, however, seems to favor the interpretation of infrequent fires.

The presence of open stands of mature limber pine and Douglas-fir suggest that these more fire-resistant growth forms can be maintained by periodic fires that clean out the intervening regeneration. Fire can act as a thinning agent that slightly favors limber pine over Douglas-fir in the younger age-classes.

Wind-driven crown fires on Fire Group One sites are a possible though infrequent event. A fire of this type can kill a stand, especially if enough time has passed since the last ground fire to allow a layer of regeneration, shrubs, or litter and other debris to form under the trees. Several of the Group One sites sampled for the Montana habitat type data base showed signs of origin following fire. Limber pine probably reestablished on these sites as a result of seed cached in the soil by Clark's nutcrackers (Lanner and Vander Wall 1980).

Section 2.3.3 Generalized Forest Succession

A generalized concept of forest succession in Group One habitats and how fire effects this succession is shown in figure 3 (subsequent numbers in this section refer to fig. 3).

Grassland sites that are potential PIFL habitat types are maintained as grassland by frequent grass fires (No. 1). It is uncertain to what extent this effect has taking place in the past, and also the frequency of fire required to prevent conifer encroachment of the grassland is not known. Where conifers have succeeded in growing to maturity, the apparent frequency of fire is low (once or twice a century). This is the state which the naturalist Ayers (1901) viewed much of the Rocky Mountain Front Range to the east of the Scapegoat

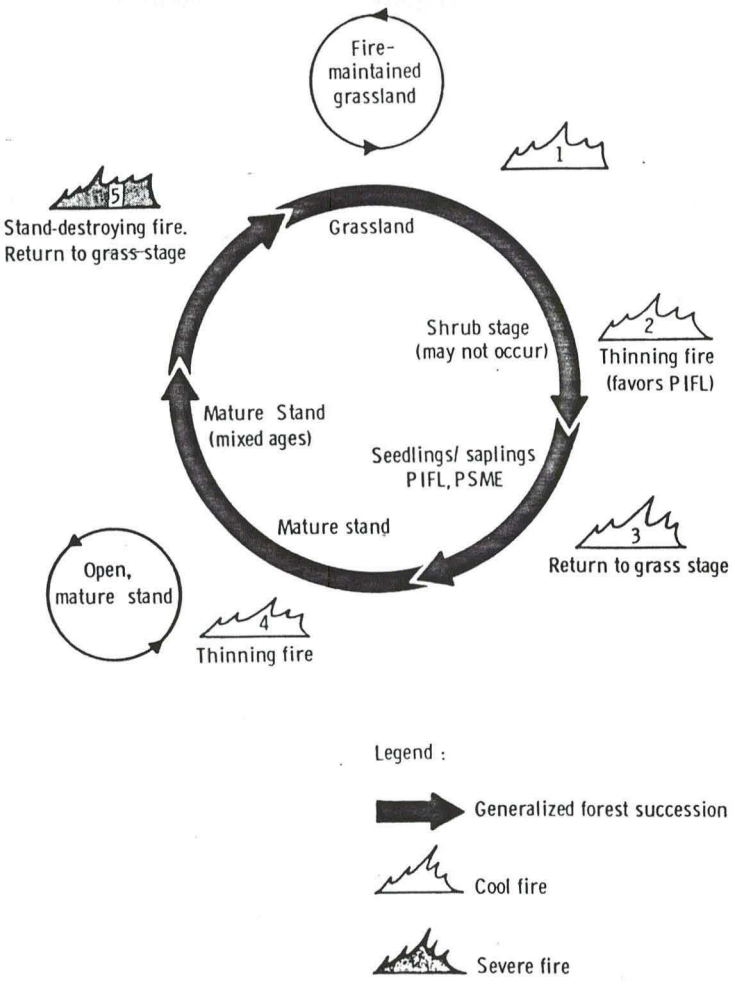


Figure 3. Generalized forest succession in Fire Group One: limber pine climax series habitat types (after Fischer and Clayton 1983).

Wilderness. An extensive fire had burned this area ten years before his travels:

> "Many of the eastern foothills now grassed proved upon closer examination to have been once wooded; for here and there upon them old charred roots and stumps are found".

A shrub stage following the grassland stage has been implied in certain PIFL habitats but not in others. The shrub stage is, for example, usually lacking on limber pine/bluebunch wheatgrass and limber pine/Idaho fescue habitat types. The shelter provided by the shrubs when they do occur apparently helps limber pine and Douglas-fir seedlings to become established. A thinning fire in the sapling period eliminates the shrubs (temporarily) and tends to favor limber pine over Douglas-fir (No. 2). Further regeneration may require the reestablishment of the shrub cover in habitats where shrubs are a factor. A severe fire in sapling stages can kill most of the trees, reverting the site to a grassland condition (No. 3).

If a fire-free period occurs long enough, the limber pine and Douglas-fir trees reach maturity and acquire some fire resistance due to their thick bark. Subsequent fires tend to thin the stand, leaving mature trees in an open fire -maintained stand (No. 4).

If fire does not thin the mature forest over a very long period (possibly centuries), then accumulating regeneration and litter could eventually contribute to a wind-driven, stand-replacing fire (No. 5). Such a severe fire reverts the site to a grassland condition, possibly for a very long time. regeneration depends on the local availability of seed and the subsequent fire history.

Section 2.4.0 FIRE GROUP TWO: WARM, DRY PONDEROSA PINE HABITAT TYPES

Fire Group Two consists of ponderosa pine stands with predominately grass undergrowth. These habitats may exist as fire-maintained grasslands and will support limber pine, Rocky Mountain juniper, and Douglas-fir as accidental individuals. In such habitat types, juniper may be a minor climax species. Sites are typically hot, dry, south- and west-facing slopes at low elevations, forming the lower timberline in the area. Slopes are often steep with poorly developed soils. Extensive stands occur on flats with poorly developed soils. Moisture stress is a critical factor for plant growth during summer months. Only minor inclusions of Fire Group Two occur within the Scapegoat Wilderness and are typically associated with droughty soils near drainages and are surrounded by Fire Groups Seven and Nine.

Section 2.4.1 Forest Fuel

Downed and dead fuel loads in Group Two are often light. The amount of material less than 3 inches in diameter rarely exceeds 5 tons/acre. The amount of material greater than 3 inches varies according to stand condition but usually accounts for 75 percent or more of the total load. The large fuel particles result from the downfall of dead trees that were unsuccessful competitors in dense stands, from deadfall following fire, and from mechanical damage caused by wind, snow, or overstory removal.

Live fuel may contribute to fire hazard in Group Two stands. Dense ponderosa pine understories often develop beneath scattered overstory trees on some Group Two sites. Fires that start in such stands often burn vigorously in the crowns of the understory trees. Consequently, fast spreading, severe fires result despite relatively light downed and dead fuel loadings. Often the most abundant surface fuel is cured grass. This is especially true for mature, open-grown stands of ponderosa pine. Fuel loads in such stands may be less than 1 ton/acre.

Section 2.4.2 **Role of Fire**

The role of fire in Fire Group Two habitats is threefold:

1. To maintain grasslands. Grassland areas capable of supporting juniper and ponderosa pine may remain treeless through frequent burning.
2. To maintain open pine stands. The open condition is perpetuated by periodic fires that either reduce the number of seedlings, remove dense understories of saplings or pole-sized trees, or thins overstory trees.
3. To encourage ponderosa pine regeneration. Fire exposes mineral soil, reduces seedling-damaging cutworm populations, reduces competing vegetation, and increases nutrient availability. Depending on the subsequent seed crop, weather, and continuity of the seedbed, regeneration may appear as dense stands, separate thickets, or scattered individuals. Periodic fires can create uneven-aged stands comprised of various even-aged groups. Severe fires will result in a predominately even-aged stand.

Historically, natural fire frequencies in forests adjacent to grasslands were fairly high, according to numerous studies conducted in ponderosa pine forest types throughout the western United States. These studies show fire to have been a frequent event, at intervals from 5 to 25 years in most locations. On the Bitterroot National Forest, Arno (1976) and Arno and Peterson (1983) reported a range of 2 to 20 years and mean fire-free intervals of 6 to 12 years for fires somewhere in small stands of 50 to 100 acres (20 to 40 ha). Fire history investigators caution that these figures are conservative estimates of past mean fire-free intervals. Intervening light ground fires could have effects on stand development without leaving scars on trees.

The effects of fire suppression during the 20th century on some sites have been confounded by the rocky, dry nature, low productivity, and the influence of grazing. In more productive sites, the absence of fire has resulted in overstocking and increased fuel. Natural regeneration is often quite slow, and in many cases fire suppression has caused little fuel buildup. In fact, on gravelly south slopes, fuel is light and variable both vertically and horizontally in spite of 50 or more years without fire. Occasionally, thickets of moderate to heavy fuel do occur, but the surrounding sparse fuel and open stand structure tend to reduce the hazard. Such areas may not be available to burn during years of low to moderate fire danger simply because of a lack of fuel. However, during severe fire danger, wind-driven fires may spread through the sparse dry fuel.

Section 2.4.3 **Generalized Forest Succession**

A generalized concept of natural forest succession for Fire Group Two sites and how fire affects this succession is shown in figure 4 (subsequent numbers in this section refer to fig. 4).

Frequent fires tend to maintain the grassland community by killing pine seedlings (No. 1). Grasses dominate the understory, but other herbaceous

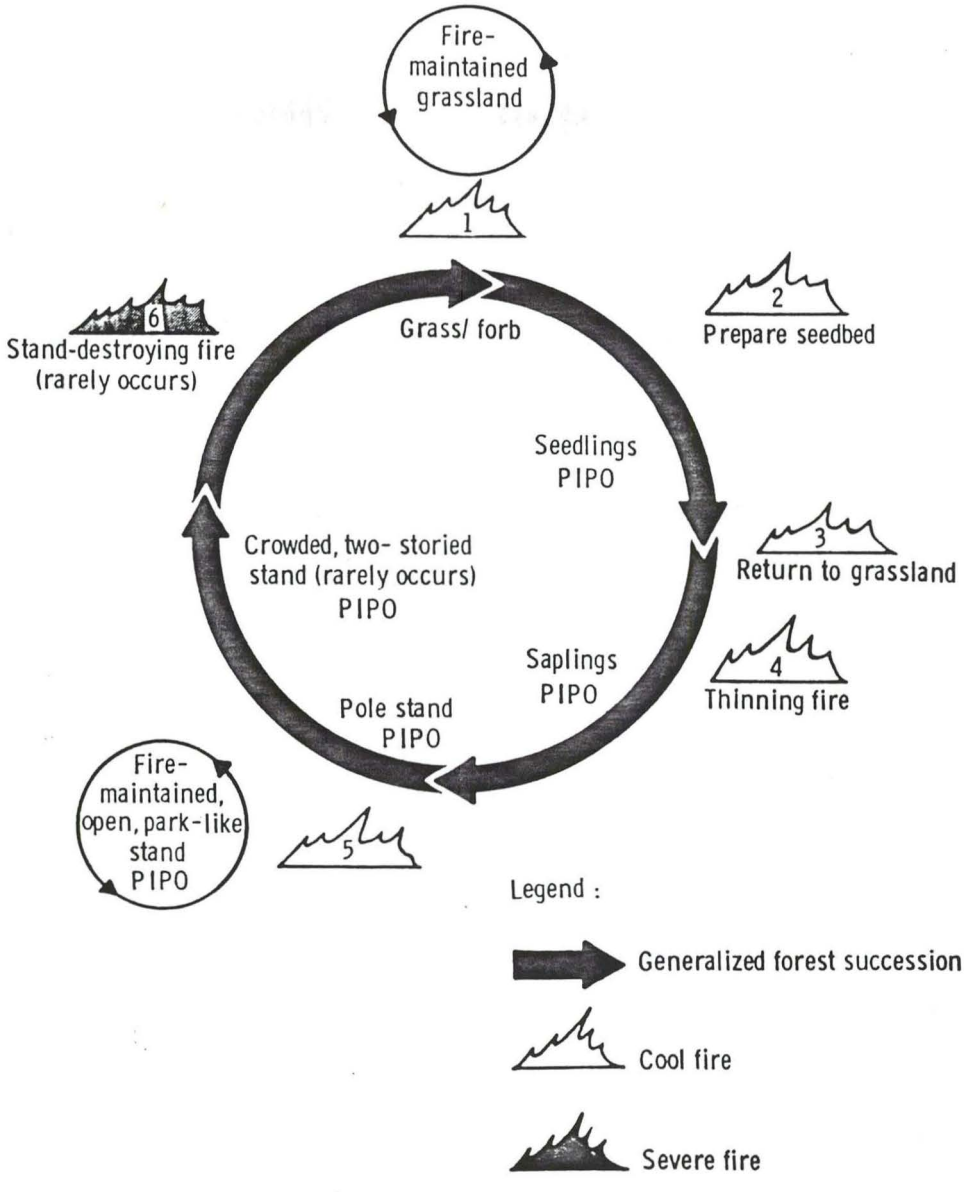


Figure 4. Generalized forest succession in Fire Group Two: warm, dry ponderosa pine habitat types (after Fischer and Clayton 1983).

plants and shrubs may be present. Ponderosa pine seedlings may become established gradually over a long fire-free period resulting in an all-aged, all-sized stand, or as a single age class following a seed-bed preparing fire (No. 2). In the absence of further burning, the seedlings develop into saplings. Fires during this period may have the effect of killing the young trees (No. 3) or thinning then (No. 4).

With sufficient time the remaining saplings mature to pole-sized trees. Subsequent light ground fires tend to produce an open stand of mature trees (No. 5). In the absence of fire, the stand may (in theory) become overstocked and accumulate enough fuel to support a severe stand-replacing fire (No. 6). In practice this situation is seldom observed in Fire Group Two stands.

Section 2.5.0 FIRE GROUP FOUR: WARM, DRY DOUGLAS-FIR HABITAT TYPES

Group Four consists of Douglas-fir habitat types where ponderosa pine usually occurs as a major seral or climax associate especially at lower elevations. Group four stands may exist as fire-maintained ponderosa pine stands that develop Douglas-fir regeneration beneath the pine in the absence of disturbance. Douglas-fir is usually present is seral stands, but ponderosa pine often dominates. These habitat types are too droughty for most other conifer species. Some Group Four habitat types extend to elevations above the cold limits of ponderosa pine. Where such situations exist, Douglas-fir dominates most states of succession. Except on the better sites, stands are usually quite open regardless of species composition. Only minor inclusions of Fire Group Four occur within the Scapegoat Wilderness and are typically surrounded by the more common Fire Groups Seven and Nine.

Rocky Mountain juniper may be a minor climax species, and occasionally limber pine may also occur. Group Four stands are generally quite open, but dense stands of Douglas-fir can occur where fire has been excluded or where good seed years and favorable moisture conditions have followed fire. The understory is usually quite sparse because it lacks moisture.

Section 2.5.1 Forest Fuel

Fuel loads in Fire Group Four are heavier on the average than those found in Fire Group Two ponderosa pine stands but lighter than those in most other groups. Down woody fuel loads average between 5 and 10 tons/acre in this group. Fuel loads in the grassy habitats usually average less than in the shrubby habitats. As a general rule, fuel loads tend to increase with the stand age as a result of accumulated downfall from insect and disease damage, blowdown, and natural thinning. This is especially true in dense, young stands where heavy mortality from natural thinning (suppression mortality) can cause rapid fuel accumulation. Fuel loads of 15 to 20 tons/acre are not uncommon in stands of these types. Fuel conditions and associated fire hazard are usually determined by stand development that in turn is governed by fire history.

Live fuel can be a significant factor in some Group Four stands. Dense thickets of Douglas-fir regeneration may become established during fire-free intervals. Overstories become susceptible to stand-replacing crown fire when such situations are allowed to develop.

Section 2.5.2 Role of Fire

In the Douglas-fir climax series habitat types, naturally occurring fires will maintain grasslands, open stands of Douglas-fir or seral ponderosa pine,

and prepare seedbeds (see Group Two). But there are additional effects (Davis and others 1980):

1. Frequent fires in seral stands maintain a ponderosa pine "fire climax" condition by killing fire-susceptible Douglas-fir seedlings. In this role, fire frequency largely determines the stand composition.

2. Following a prolonged fire-free period, Douglas-fir regeneration became established beneath the canopy. A ground, or surface fire that reached the thicket of saplings and small poles could ascend into the overstory, killing or injurying adjacent mature trees through the vegetative "fuel ladder." Fuel ladders increase the potential destructiveness of a fire by providing access to the canopy. During periods of high fire danger, this often resulted in a stand-replacing crown fire.

Historic fire frequency was probably not very different from Fire Group Two, usually 5 to 20 years or more years between fires. Successful suppression of surface fires in open, fire-maintained stands over the last few decades has altered the sites toward a more flammable condition that has increased the potential for a fire to become severe.

Section 2.5.3 Generalized Forest Succession

The theoretical climax forest is an all-aged or multistoried Douglas-fir forest, as shown in figure 5 (subsequent numbers in this section refer to fig. 5). Such a forest is unlikely to be achieved because of the prolonged fire-free interval necessary for its development. Most old-growth forests will be open stands with varying understories depending on the stand's fire history. A grass/forb community with shrubs and conifer seedlings becomes established following a severe stand-replacing fire (No. 1). Frequent fire during this stage can result in a fire-maintained grassland (No. 2). A low severity burn during the herb/shrub stage may result in a seedbed favorable to conifer seedlings, but this may be unimportant where seedling establishment is not hindered by ground cover.

In the absence of fire, the herb/shrub stage gives way to conifer seedlings. Except on those high-elevation sites above the cold limits, ponderosa pine will dominate initially if it dominated the prefire stand. Douglas-fir seedlings will also be present. Variation in seed cone crops is a factor in regeneration. A poor seed year often retards regeneration. A fire at this stage reverts the site to an herb/shrub state (No.3).

In the absence of fire, ponderosa pine and Douglas-fir saplings develop. Species composition and density of stems depends on site conditions, length of the regeneration period, and how long fire has been absent. Not much ponderosa pine, for example, will be present if fire is absent for a prolonged period. A severe fire returns the site to the herb/shrub stage (No. 5). A low severity to moderate severity fire tends to thin out Douglas-fir saplings and badly suppressed ponderosa pine saplings (No. 4). A low severity fire at his stage will also remove any recent seedlings.

The pole-sized tree stage can be represented by (1) a rather open stand of Douglas-fir and ponderosa pine poles with a scattered seedling and sapling understory, (2) a predominately ponderosa pine or Douglas-fir pole stand with varying understory, or (3) a scattered pole stand with grass/forb/shrub understory. A low to moderate severity fire at this stage may thin the stand, removing understory vegetation and susceptible Douglas-fir stems (No. 6). Frequent fire maintains open, parklike stand of ponderosa pine on most sites. A severe fire reverts the site to the herb/shrub stage (No. 7).

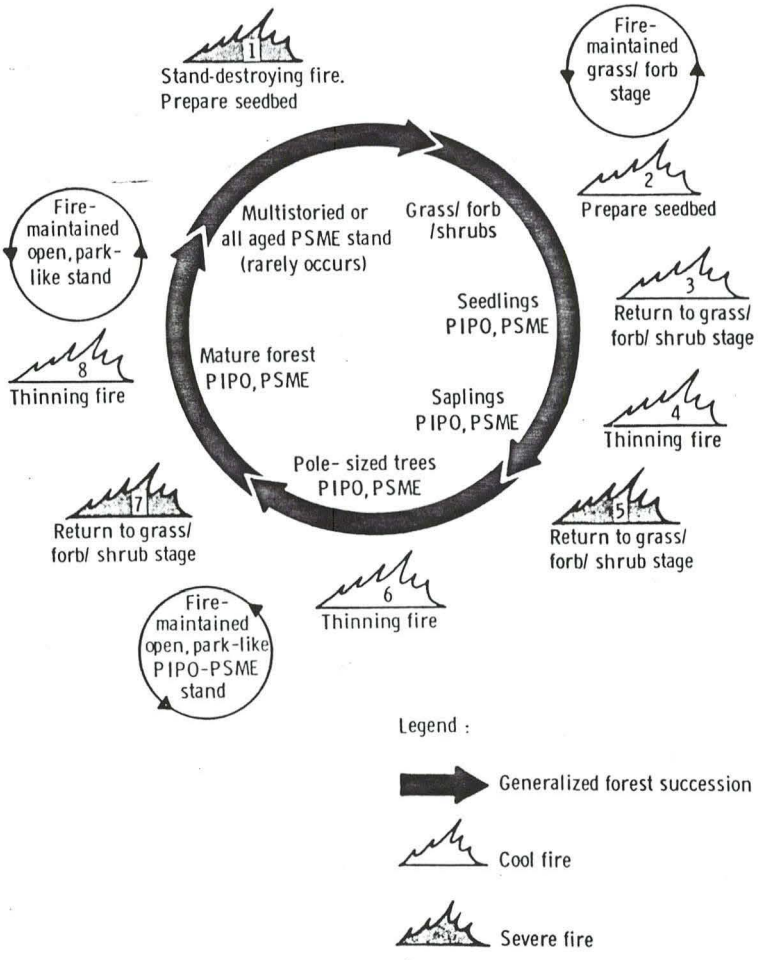


Figure 5. Generalized forest succession in Fire Group Four: warm, dry Douglas-fir habitat types (after Fischer and Clayton 1983).

A mature forest of ponderosa pine, Douglas-fir, or a combination of the two, will eventually develop. Periodic fire at this stage maintains the stand in an open, parklike condition (No. 8). Douglas-fir and some ponderosa pine regeneration may form in the understory of such stands during fire-free intervals. If fire is excluded for an unusually long period, the theoretical climax situation could develop.

Section 2.6.0 FIRE GROUP FIVE: COOL, DRY DOUGLAS-FIR HABITAT TYPES

Fire Group Five habitat types support Douglas-fir stands even under the influence of periodic fire. Douglas-fir is the indicated climax species on most of these sites. It dominates most seral communities and often is the only conifer present. Sites are apparently too dry for lodgepole pine and too cold for ponderosa pine. Rocky Mountain juniper, whitebark pine, lodgepole pine, limber pine, and subalpine fir may occur as accidental individuals, minor seral species, or minor climax species. An estimated 10 percent of the land area covered by the Scapegoat Wilderness and Danaher portion of the adjacent Bob Marshall Wilderness are within this Fire Group (USDA 1981). Fire Group Five occupies as much as 50 percent of the moderately dissected, and smooth residual slopes within the wilderness. These areas typically are steep (25 to 60 percent slope), south or west facing mountain slopes supporting a mosaic of dense forest (Fire Group Seven, 30%), open grown timber (Fire Group Five), and open grasslands (Fire Group Zero) with small inclusions of Fire Group Six. Elevational range is approximately 5,000 to 6,800 ft msl. Annual precipitation ranges from about 20 inches east of the Continental Divide to 60 inches on the west side. This Fire Group is also prominently represented east of the Scapegoat Wilderness boundary on National forest and private lands. Timber recovery following fire may be slow, greater than sixty years, because Douglas-fir invasion on these sites is difficult. Herbaceous recovery is rapid, and following fire it is often difficult to differentiate between natural occurring mountain grasslands or unregenerated old burns.

Section 2.6.1 **Forest Fuel**

Downed, dead fuel loads average 10 tons/acre. While downed, dead woody fuel loadings are greater in most cases than found in Fire Groups One, Two and Four, live fuel is of less concern. Both undergrowth and regeneration are usually sparse. This factor plus the usual open nature of the stands result in a low probability of crown fire. Individual trees will often have branches close to the ground. If sufficient fuel is available on the ground torching can occur.

Section 2.6.2 **Role of Fire**

Fire occurred less frequently within Group Five habitat types than it did within ponderosa pine habitat types (Group Two) or within the warmer Douglas-fir habitat types (Group Four). The relatively light fuel loads, sparse undergrowth, and generally open nature of the stands would appear to favor long fire-free intervals. However, Arno and Gruell (1983, 1986) estimated a mean fire interval of 35 to 45 years in presettlement stands in southwestern Montana.

Fire's role in seedbed preparation is confounded by the difficulty of regeneration to progress beyond the seedling stage on these droughty sites because of undergrowth and overstory competition. Where dense regeneration does occur, fire probably played a role as a thinning agent in sapling and

pole-sized stands. Ground fire probably maintained many mature stands in an open, parklike condition. Many presettlement stands were actually maintained as seral grasslands with scattered trees inhabiting rocky microsites. The prolonged absence of fire has allowed these groves to become forest stands (Arno and Gruell 1983, 1986).

Section 2.6.3 Generalized Forest Succession

The generalized forest succession discussed here and illustrated in figure 6 (subsequent numbers in this section refer to figure 6) assumes sites are above the cold limits of ponderosa pine.

Frequent fire could maintain sites as grassland (No. 1). A fire in the herb/shrub stage will prepare a seedbed (No. 2) for Douglas-fir seedlings. Seedling establishment is usually slow and probably requires favorable combination of adequate seedbed, adequate moisture, and abundant seed. When favorable conditions for seedling establishment do occur, an even-aged stand usually develops. Any fire in either the seedling stage or the sapling stage reverts the site to a treeless condition (No. 3).

A light surface fire in a pole-sized stand usually thins out the more susceptible stems (No. 4). A severe fire in pole-sized stands (No. 5) is likely to kill all trees and again revert the site to the herb/shrub stage. A less-than-severe fire in a mature stand (No. 6) may act as an underburn and thin the stand, thereby creating an open stand condition and result in a parklike Douglas-fir stand. If a stand escapes fire and nears the climax situation, it will likely have a Douglas-fir understory, sparse undergrowth, and moderate amounts of dead fuel on the forest floor. A light fire would remove the understory and reduce dead woody fuel (No. 7). A severe fire in a climax or near climax stand would either destroy the stand and revert the site to the herb/shrub state or thin the overstory and leave an open parklike stand (No. 8).

Section 2.7.0 FIRE GROUP SIX: MOIST DOUGLAS-FIR HABITAT TYPES

Fire Group Six habitat types occur usually at elevations between 5,000 and 6,500 ft msl and on north or east facing aspects. Douglas-fir is both the indicated climax species and a vigorous member of the seral communities. It is not uncommon for Douglas-fir to dominate all stages of succession on these sites. Ponderosa pine, western larch, and lodgepole pine are seral components whose abundance varies considerably by phase.

Whitebark pine is usually well represented at upper elevations within the Douglas-fir/pinegrass habitat type-pinegrass phase (PSME/CARU-CARU). Subalpine fir and spruce are essentially absent. At low elevations, Group Six sites can be found on all aspects. On cooler sites, ponderosa pine becomes less important and larch and lodgepole pine increase in importance.

Shrubs and moist forbs dominate the undergrowth, along with pinegrass and elk sedge.

Only about 1 percent of the total land area included in the Scapegoat Wilderness and the adjacent Danaher portion of the Bob Marshall Wilderness are in this Fire Group (USDA 1981). Typically Fire Group Six is surrounded by the more common Fire Groups Seven and Nine, and Five.

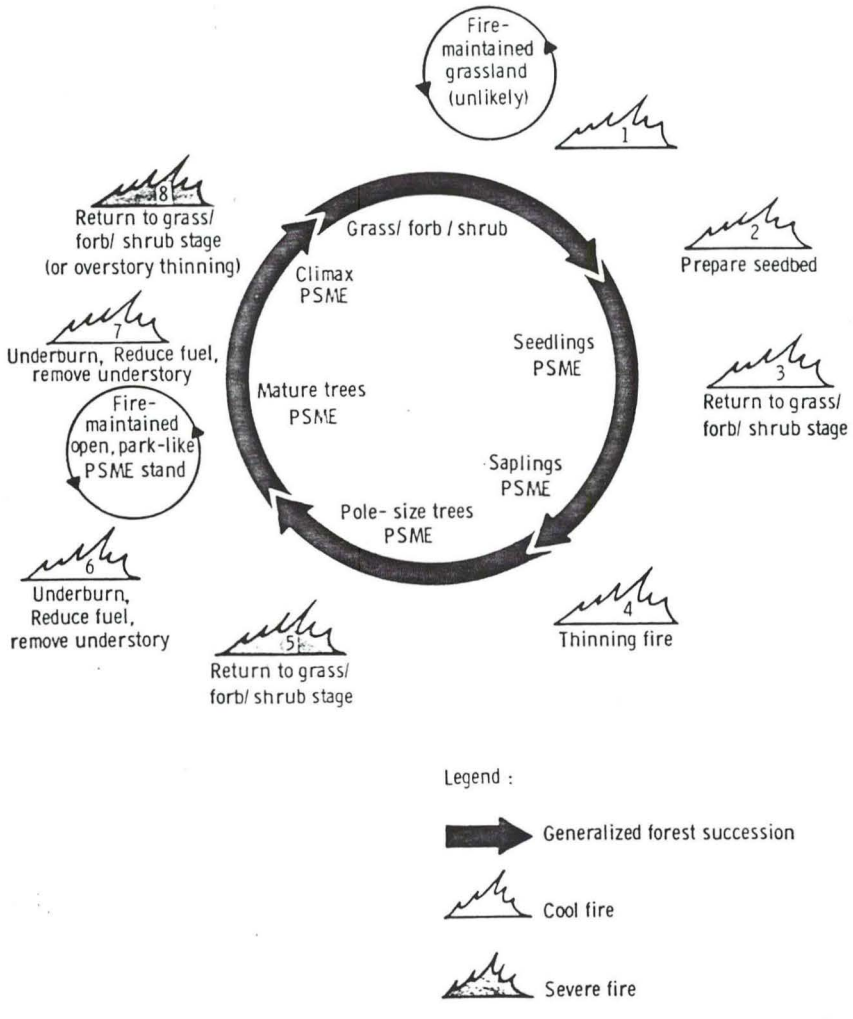


Figure 6. Generalized forest succession in Fire Group Five: cool, dry Douglas-fir habitat types (after Fischer and Clayton 1983).

Section 2.7.1 **Forest Fuel**

Downed, dead fuel loads average about 12 tons/acre, but can be much heavier. Fuel loads have been shown to range from 1 to 74 tons/acre. Fuel conditions will vary according to stand density, species composition, age, and stand history. Two Fire Group Six stand sampled east of the Continental Divide within the Scapegoat Wilderness and considered typical of the fuel within their respective areas contained 23.5 tons/acre under a 120 year old lodgepole pine overstory, and a "mostly light ground fuel" indicating probably 1 to 2 tons/acre under a 180 year lodgepole pine overstory. The tendency toward overstocking and the development of dense understories result in high-hazard fuel conditions in many stands. Natural thinning, snow breakage, blowdown, and insect and disease mortality operate at a high level in many stands. Relatively deep duff often develops and may contain a lot of rotten logs. Fires often smolder undetected until burning conditions become favorable for fire spread.

The most hazardous conditions occur in well-stocked stands with dense Douglas-fir understories. These stands are characterized by relatively large amounts of downed twigs and small stems and branchwood less than 3 inches in diameter beneath partially fallen and standing dead saplings and small pole-sized stems. The absence of dense understories results in a reduced fire hazard, however the density of overstory trees and the presence of dead branches near ground level can create a crown fire potential under severe burning conditions.

Fuel conditions in stands dominated by lodgepole pine tend to be less hazardous than stands dominated by Douglas-fir. Ladder fuels are much less prevalent, so the probability of fire going from the forest floor to the crowns is not as great.

Section 2.7.2 **Role of Fire**

Fire history studies conducted within a PSME/CARU habit type in southwestern Montana indicate a mean fire interval of 42 years for presettlement stands (Arno and Gruell 1983). A tentative mean fire-free interval of 15.8 years was reported by Habeck (Crane and others 1983) within a Douglas-fir/ninebark habitat type-ninebark phase (PSME/PHMA-PHMA) near Missoula, MT.

Fire was an important agent in controlling density and species composition. Low to moderate severity fires converted dense stands of pole-sized or larger trees to a more open condition, and subsequent light burning maintained stands in a parklike state. Frequent low or moderate fires favored larch and ponderosa pine over Douglas-fir in stands where these species occurred. Severe fires probably resulted in stand replacement. Stand-replacement fires favored lodgepole pine on sites where this species was present.

Fire's role as a seedbed-preparing agent is less important in this group than in previously discussed groups. Doulas-fir can establish on a variety of seedbeds and is not dependent on mineral soil conditions for successful regeneration.

Fire's role as a stand replacement agent becomes more pronounced when the natural fire-free interval is increased through fire suppression, or a moist climate cycle, unless corresponding fuel reduction occurs.

Section 2.7.3 Generalized Forest Succession

The theoretical climax condition on Group Six sites is a multistoried Douglas-fir stand, although a fire-maintained open forest condition was the normal situation during the presettlement period, as shown in figure 7 (subsequent numbers in this section refer to figure 7). Following a severe, stand-replacement fire (No.1), grass, forbs, and shrubs dominate the site. Subsequent fires in this stage perpetuate herbs and shrubs (No. 2). Seedlings of Douglas-fir, lodgepole, and larch may become established if the fire-free interval is of adequate length. A fire in the seedling stage (No. 3) most likely returns the site to herbs and shrubs, although some ponderosa pine seedlings may survive some low severity fires.

Low or moderate severity fires in the sapling stage (No. 4) thin the stand, if ponderosa pine and western larch are dominate, or eliminate Douglas-fir and lodgepole pine where these species are major components.

Many pole-sized Douglas-fir, western larch, and ponderosa pine will survive low to moderate fires (No. 6), which may serve to increase seral species as well as thin the stand. Severe fires kill trees of all species (No. 5). If serotinous trees are present, a new stand of nearly pure lodgepole pine initiates from their seeds.

Low to moderate fires (No. 7) in mature mixed conifer stands thin them, while severe fires revert these sites to the shrub/herb stage.

Climax Douglas-fir stands are rare because of the presence of seral species whose longevity is greater than the usual fire-free interval. Climax stands are more likely to occur on sites where Douglas-fir is the seral dominate as well as the climax species. Frequent low to moderate fires in the climax conditions on these sites will create a more open, parklike stand of Douglas-fir (No. 8), whereas a severe fire returns the stand to the shrub/herb stage (No. 9).

Section 2.8.0 FIRE GROUP SEVEN: COOL HABITAT TYPES USUALLY DOMINATED BY LODGEPOLE PINE

Fire Group Seven contains two groups of habitat types. The first group consists of lodgepole pine climax series habitat types (and community types) that support essentially pure stands of lodgepole pine, which constitutes the persistent dominant species on these sites. The other group consists of those Douglas-fir, spruce, and subalpine fir habitat types that are usually found supporting lodgepole pine-dominated stands. Wildfires evidently recycle the stands before the lodgepole pine dies out, and frequently long before climax forest conditions are ever attained.

Subalpine fir, spruce, Douglas-fir, and white-bark pine occur in varying amounts with lodgepole pine on most sites. Undergrowth often consists of dense mats or layers of grasses or shrubs.

Fire Group Seven covers the largest aerial extent, approximately 25 percent, of any fire group within the Scapegoat Wilderness and adjacent Danaher portion of the Bob Marshall Wilderness (USDA 1981). The most prominent location of this fire group is on nearly level to gently sloping, well drained glacial outwash and alluvial plains, between 4,800 to 5,200 ft msl elevation. On these sites the annual precipitation ranges between 20 and 30 inches with approximately 40 percent in the form of snow. They are very susceptible to cold air drainage from the higher slopes, and as a result late spring and early summer frosts are common. Fall temperature inversions are also a common occurrence. Adjacent to these landform features Fire Group Seven is found on

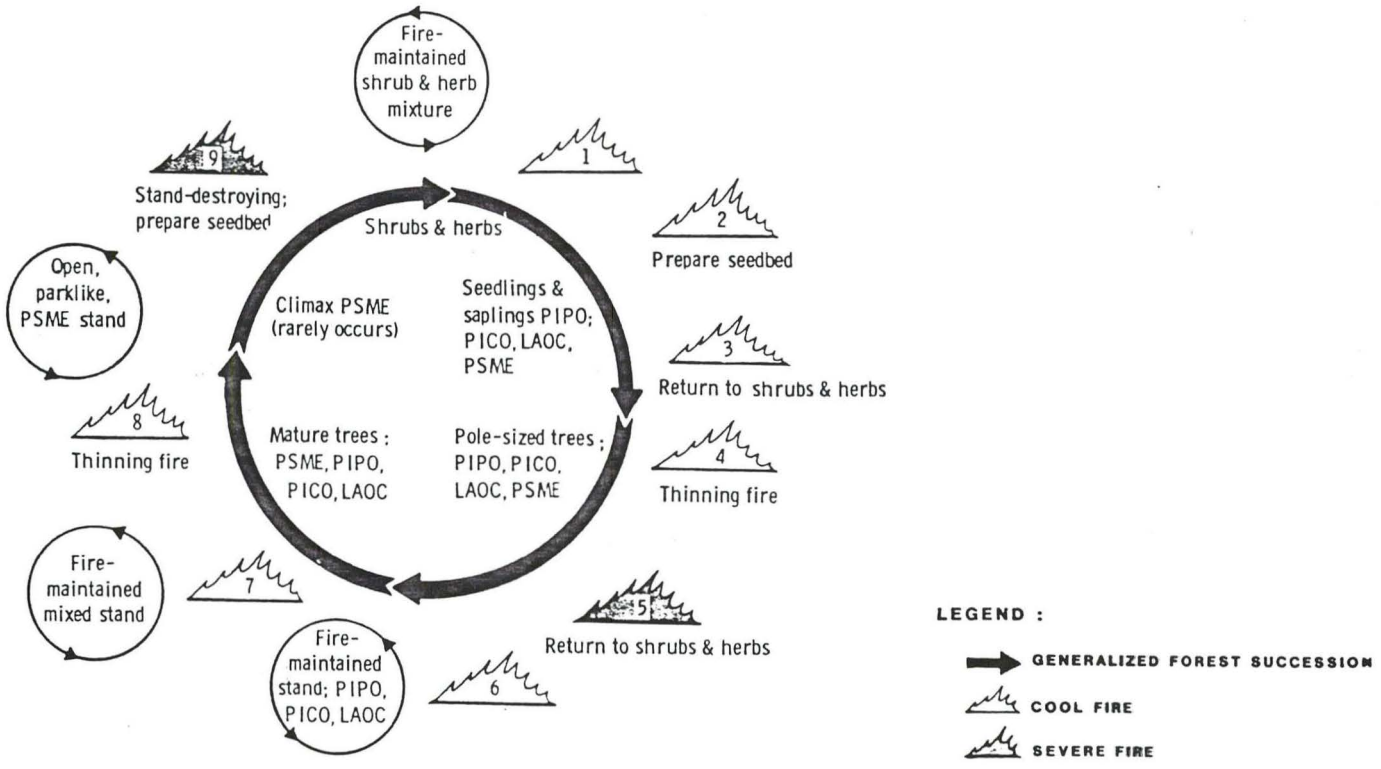


Figure 7. Generalized forest succession in Fire Group Six: moist Douglas-fir habitat types (after Fischer and Bradley 1987).

forested ground moraines comprised of rolling to hilly valley floors containing glacial drift deposits and glacial scoured low relief bedrock hills. These areas extend from 4,600 to 5,600 ft msl with a slightly greater range of annual precipitation of 20 inches to the east up to 50 inches in the west. Fire Group Seven is also found on smooth residual slopes, steep lateral moraines, and breaklands. On these features the fire group forms only a portion of the forested mosaic, usually on north and east slopes and between 5,000 to 7,500 ft msl elevation. Greater altitudes may be reached but usually as inclusions within other fire groups. These sites are steeper, between 25 to 70 percent slope, and may receive greater annual precipitation, up to 60 inches west of the Continental Divide.

Section 2.8.1 **Forest Fuel**

The average downed woody loading is about 15 to 18 tons/acre. Inventories have shown a range of about 3 to 35 tons/acre, but maximum loads may greatly exceed this range. Mathews (1980) reports extreme fuel loads in excess of 150 tons/acre in west-central Montana (East Fork of the Bitterroot River drainage near Sula, MT). A fuel inventory in the Scapegoat Wilderness indicated fuel in this fire group being light east of the Continental Divide with 3.4 tons/acre being considered typical, and fuel on the west side of the divide averaging between 4 and 12 tons/acre and being as high as about 20 tons/ac on wet sites which had remained unburned during the last century and still retained heavy surface fuel from earlier fires.

Fuel loads are characterized by relatively large amounts of material 3 inches or more in diameter. At least half the total weight is usually contributed by large material. As a general rule, the proportion of the total fuel load made up of 3 inches or more in diameter increases as the total load increases.

Live fuel can be a problem but not to the extent they are in some other Fire Groups. The primary live fuel consideration is related to the occurrence of dense patches or entire stands of young lodgepole pine with intermingled crowns and entire lower branches extending down to the surface fuel. When ignited under favorable conditions, such stands are usually destroyed in a few minutes.

Many mature stands are characterized by densely stocked, clean-boled trees with large amounts of deadfall on the forest floor. An immediate source of deadfall in a young lodgepole stand is the snags created by a previous fire. Lyon (1984) found that after 2 years with little windthrow, lodgepole pine snags on the Sleeping Child Burn (Bitterroot National Forest) fell at an annual rate of 13.4 percent. Overall, an average of 497 snags/acre was reduced to an average of 75 snags per acre after 15 years. After 21 years nearly 93 percent of all snags had fallen. Ten years after the 1889 fires in the Lewis and Clark Forest Reserve, Ayers (1901) described fuel conditions in the burned and unburned portion of the Danaher Creek (Willow Creek) area of the future Bob Marshall Wilderness:

> "There is only a moderate amount of litter, even on the burns. Most of the fires that have occurred have been severe and have cleaned up the smaller litter quite thoroughly. That falling since the fire of 1889 is coarse and principally the trunks of trees killed by that fire. In the unburned woods the trees killed by overcrowding and the branches that are

overshaded and drop accumulate to a moderate amount, but are seldom so abundant as to obstruct the passage of horses through the woods".

Aside from fire-created snags, sources of deadfall are thinning, snow breakage, and windthrow of live trees, dwarf mistletoe mortality, and mountain pine beetle attack and subsequent mortality. Mountain pine beetle attack is often the mechanism that causes the lodgepole pine stand to break up. Cumulative mortality during a mountain pine beetle epidemic (duration of about eleven years) frequently amounts to 85 percent or more of the large, 8 inches diameter trees in a lodgepole pine stand (Cole and Amman 1980).

Section 2.8.2 **Role of Fire**

On sites below 7,500 ft the role of fire in seral lodgepole forests is almost exclusively as an agent that perpetuates or renews lodgepole pine. Without periodic disturbance, the shade-tolerant species replace lodgepole because it does not regenerate well on duff or under shaded conditions. Fire interrupts the course of succession and increases the proportion of lodgepole with each burn. Within 50 to 100 years following a severe fire in a lodgepole-dominated stand, a reestablished lodgepole pine forest will exist even though shrubs and herbaceous cover may become dominant immediately following the burn.

Large-scale stand-replacing fires play a major role in the ecology of lodgepole pine stands. The natural periodicity of severe fires in seral lodgepole stands probably ranges from less than 100 years to about 500 years (Hendrickson 1970). A frequency of reoccurring severe fires within portions of the Scapegoat Wilderness was estimated to be about 130 to 150 years (USDA 1981). This time estimate for fire return intervals in the Scapegoat Wilderness within this fire group may be high, especially during the last several hundred years. Recurring cool fires may thin the stand or otherwise rejuvenate it without doing serious damage. However, in stands greater than 60 to 80 years old, fuel will build up to hazardous levels due to natural thinning, mountain pine beetle outbreaks, drawf mistletoe infestations, and fire-killed timber (snags) from previous fires. Eventually a chance ignition, followed by a major weather front passage with associated strong winds sets off a major conflagration. Such a fire may cover thousands of acres. Vast tracts of lodgepole can develop in this way as the serotinous cones open and shower the burn with seeds. The Sleeping Child Burn on the Bitterroot National Forest in western Montana is one example in modern times (Lyon 1984).

The almost exclusive dominance of lodgepole pine within the lodgepole pine community types is attributed in large part to fire. Pfister and others (1977) suggest the following reasons for the absence of other species on lodgepole pine climax series sites:

1. Historic, repeated fires over large areas may eliminate seed sources of potential shade-tolerant competitors.
2. Light ground fires may remove invading shade-tolerant competitors from the understory.
3. Dense stands may prevent regeneration of all conifers for up to 200 years in the absence of disturbance or stand deterioration.
4. Sites may be unfavorable for the establishment of other conifers.

Ayers (1901) in his travels through the Lewis and Clark Reserve commented on this phenomena:

> "On the older burns it is common to find dense stock of saplings; but these, are as a rule, are principally lodgepole pine, especially on the slopes east of the Continental Divide. Engelmann spruce and red fir [Douglas-fir] have made their appearance on some of the old burns, but rather subordinate to lodgepole pine. In rapidity of growth they are inferior, and in numbers the constitute but a small proportion of the new forest".
>
> "Willow Creek, however, is fairly well stocked, but all the young growth there is small, usually from 2 to 10 feet high... the severe burns have little else than lodgepole pine".

Red fir is one of the many early common names used for Douglas-fir which has been included in brackets.

Above 7,500 ft the role of fire in lodgepole pine forests appears to differ from the classic pattern. At these altitudes the fire season is relatively short in most years, productivity is low, and mountain pine beetle activity is inhibited by low temperatures and the short growing season. Romme (1980, 1982) has estimated a mean fire interval of 300 to 400 years for stand-replacing fires in subalpine forests of Yellowstone National Park. However, parts of that area have some extreme edaphic conditions such as soils composed of pure obsidian sand and the occurrence of severe yearlong frosts which create physiological conditions intolerable to any conifer except lodgepole pine. The spread of fire is often limited in the high elevation forests. Small, lightning-caused fires burn out patches of forest several acres in area and then die out. The result may be a mosaic of age classes, not the uniform single-aged forests prevalent on many lower elevation sites (Day 1972).

Section 2.8.3 Generalized Forest Succession

The theoretical climax forest will vary according to habitat type as shown in figure 8 (subsequent numbers in this section refer to (figure 8). Except for stands within the lodgepole pine community types and the lodgepole pine/bitterbrush (PICO/PUTR) habitat type, however, the climax situation is rarely achieved. Fire almost always interrupts succession before a near-climax condition develops, often even before the forest stand can achieve mature forest condition.

Following a stand-replacing fire, a short-lived herb/shrub stage dominates. This stage is short-lived because the lodgepole pine seedlings quickly become established and overtop the undergrowth. However, a fire in the herb/shrub stage (No. 1) will extend its period of dominance. Recurring fire at frequent intervals could conceivably maintain the site in herbs and shrubs. A fire during the seedling/sapling stage also returns the site to herbs and shrubs (No. 2). The likelihood of a fire at this stage is not great on most sites.

The effect of fire during the pole stage depends on fire severity. A low severity fire (No. 3) thins the stand while a severe fire (No. 4) destroys it. The severe fire of the two types may appear to be the more common fire type in

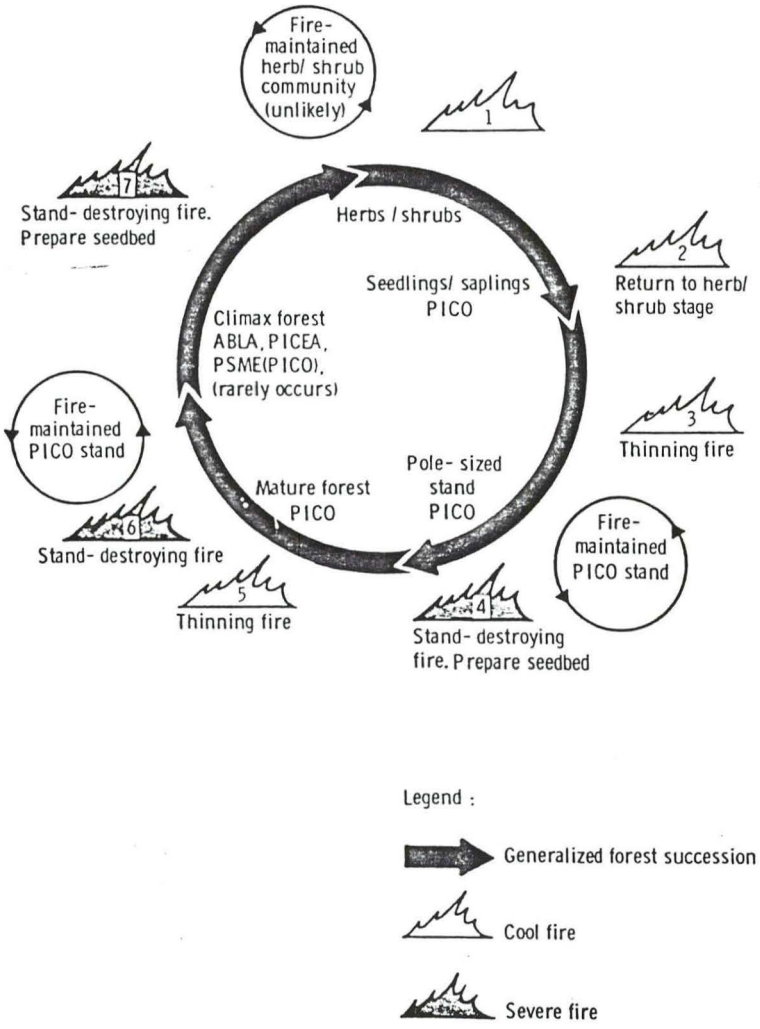


Figure 8. Generalized forest succession in Fire Group Seven: cool habitat types usually dominated by lodgepole pine (after Fischer and Clayton 1983).

the pole stage. This is because this type of fire would cover a more extensive area. Low severe fires may be more common but will have little spread and result in considerably less burned acreage. Because pole-sized lodgepole pine usually contain serotinous cone crops, periodic fire at this stage can result in a fire-maintained lodgepole pine stand. The effect of fire in a mature lodgepole forest is essentially the same as in the pole forest. A low severity fire thins the stand and a severe fire recycles the stand (Nos. 5 and 6). The probability of a severe stand-replacing fire greatly increases as a previously unburned mature stand starts to break up and an understory of climax species develops. It is usually at this stage rather than the climax stage that fire destroys the stand (No. 7).

While Ayers (1901) was traveling through the North Fork of the Blackfoot River drainage (probably the north/south oriented valley to the west of the Continental Divide which was also missed by the 1988 Canyon Creek Fire) within the Scapegoat Wilderness, and the Danaher Creek (Willow Creek) portion of the South Fork of the Flathead River in the Bob Marshall Wilderness he described some of the forest succcession following fire in this fire group. The fire referred to occurred in 1889, ten years before his visit:

> "Along the borders of surviving forests conditions seem to be favorable for reproduction. In such places the forest has furnished seed, which has found a good place to germinate in the bare surface left by the fire. Away from the green woods, however, and in the high altitudes, where seeding is less abundant and where the less productive balsam and spruce prevail, the young stock is far less abundant. In the valley of Willow Creek reproduction is especially good, and 40,000 young lodgepole pine to the acre are frequently found. Some of the damper areas have a stock of Engelmann spruce and red fir or larch. The areas subjected to repeated fires have very little new growth, and this is almost invariably lodgepole pine".

> "The effects of the fires upon the composition of the forest has been to increase the proportion of lodgepole pine. Probably 90 per cent of the stock coming is of this species". ... "On old burns some inclination to return to the original species was found, notably on the head of the North Fork of Blackfoot River, where spruce was found coming in under lodgepole pine. larch, red fir, and white pine, too, sometimes reappear under lodgepole pine on old burns, but this reappearance is always slow ... ".

Section 2.9.0 FIRE GROUP EIGHT: DRY, LOWER SUBALPINE HABITAT TYPES

Fire Group Eight consists of dry lower subalpine habitat types where spruce or subalpine fir are the indicated climax species. Frequently these sites are at the lower, warm, dry limits of subalpine fir. West of the Continental Divide in the spruce/starry false Solomon's seal (PICEA/SMST) habitat type and the subalpine fir/beargrass habitat type-huckleberry phase (ABLA/XETE-VAGL) occur in this fire group. PICEA/SMST occurs mostly between 5,000 and 7,000 ft msl on warm, moist benches and lower slopes. ABLA/XETE-VAGL is found on dry slopes and ridges between 5,000 and 6,300 ft msl. Both of these habitat types

may also be found east of the Continental Divide along with three other habitat types (subalpine fir/pinegrass [ABLA/CARU], subalpine fir/virgin's bower [ALBA/CLPS], and subalpine fir/heartleaf arnica [ABLA/ARCO]). All of the later three habitat types are found on calcareous substrates.

Douglas-fir and lodgepole pine are dominant seral species, with lesser amounts of spruce, and occasional larch. The prevalence of Douglas-fir and lodgepole pine may be due, in part, to periodic fire that sets back the invasion of subalpine fir and spruce. East of the divide limber pine is a long-lived seral dominant on ABLA/CLPS sites. Whitebark pine occurs as an accidental or minor species throughout the east side potions of the fire group and may be a major seral component in some ABLA/CLPS stands.

Stands usually contain luxuriant undergrowth of grasslike species, shrubs and herbs.

Only small inclusions of Fire Group Eight occur in the Scapegoat Wilderness.

Section 2.9.1 **Forest Fuel**

Downed dead woody fuel loadings average about 18 to 20 tons/acre. Maximum loads may greatly exceed these values. Fuel loadings of 1 ton/acre to about 80 tons/acre were measured during fuel inventories in this fire group in western Montana (Fischer 1981b). With few exceptions, 20 tons/acre represented the low end of the range of loadings encountered during that inventory. Sampled stands in Fire Group Eight east of the Continental Divide within the Scapegoat Wilderness averaged about 12 tons/acre and ranged as high as 32 tons/acre. West of the divide in the Scapegoat Wilderness values were similar and ranged from averages of 7 to 12 tons/acre to about 20 tons/acre for an ABLA/XETE stand breaking up on top of Lake Mountain.

Stands are characterized by relatively large amounts of downed woody fuel of all size classes, but especially large amounts of material greater than 3 inches in diameter. A large amount of material in the 10 and 20 inch diameter class is common.

As is the case within many subalpine fir habitat types, live fuel can contribute significantly to overall fire hazard during dry conditions. Early frosts at these higher elevations helps cure the herbaceous component. Dense understories develop in many stands and provide fuel ladders to the overstory tree crowns, although some stands are devoid of such understories.

Relatively deep duff layers may form. When the duff is dry, fire in the duff can cause considerable mortality by heating the shallow roots of subalpine fir and Engelmann spruce.

Section 2.9.2 **Role of Fire**

Fire history data for the lower subalpine habitat types in the Northern Rocky Mountains have been summarized by Arno (1980). He reported that almost 60 percent of all mature (greater than 100 years) western Montana ABLA/XETE stands sampled showed obvious evidence of ground fire after establishment.

The occurrence of periodic low to moderate severity fire favors Douglas-fir and lodgepole pine. Such fires set back invasion by the more tolerant subalpine fir and spruce, which in the absence of fire form dense understories and eventually take over the site. Fires of moderate severity probably help Douglas-fir maintain a position of dominance or codominance with lodgepole pine in many stands. The more fire-resistant Douglas-fir has a better chance of surviving such fires and is able to successfully regenerate in fire-created

openings where mineral soil has been exposed. Severe, stand replacing fire will generally favor lodgepole pine on many of these sites. Some large, thick-barked Douglas-fir trees will often survive fires severe enough to kill all the lodgepole pine trees, thereby assuring the presence of Douglas-fir in the new stand. Ayers (1901) briefly described some of his observations on forest stands which evidently fall within this fire group, and which had experienced either multiple low to moderate severity fires or a single severe fire:

> "The stock on lightly burned regions, as a rule, is not only mixed as to species, but also as to size. There are some areas on old burns which are occupied by lodgepole pine only, but these are the exception and are not large".

Before organized fire suppression, fire intervals probably fell between those reported for Fire Group Seven lodgepole pine stands (about 50 years) and those identified for the more moist lower subalpine types of Fire Group Nine (90 to 130 years).

Section 2.9.3 Generalized Forest Succession

Generalized forest succession in the dry lower subalpine habitat types of Fire Group Eight is similar to the moist lower subalpine habitat types of Group Nine. The major difference between the two is that the drier Group Eight stands experience more frequent, generally less severe fires than Group Nine stands.

Because of the similarity of fire-related forest succession in the two groups, generalized forest succession is jointly discussed under Group Nine.

Section 2.10.0 FIRE GROUP NINE: MOIST, LOWER SUBALPINE HABITAT TYPES

Fire Group Nine is a collection of moist and wet lower subalpine habitat types in the spruce and subalpine fir climax series. This is the second most common fire group, and covered approximately 20 percent of the area within the Scapegoat Wilderness and the adjacent Danaher portion of the Bob Marshall Wilderness (USDA 1981). Soils are moist or wet (supersaturated with water) much of the year. Low floodplains and associated glacial terraces along 3rd to 6th order streams in the wilderness are an important portion of the fire group. These sites typically border streams and adjoin wet meadows from 4,500 to 5,500 ft msl elevation. These sites are near the lower end of the annual precipitation range for Fire Group Nine; from 25 to 35 inches with 40 percent at the lower elevations and up to 60 percent on higher sites arriving in the form of snow. Other typical locations within this landform include flat sites with poor drainage, moist bottomlands, benches, northern exposures, and seepage areas on southern exposures. The fire group extends up into densely forested steep lateral moraines, ground moraines, smooth residual slopes, moderately dissected slopes, slumpland, and cool aspect breaklands. These land forms have an annual precipitation range from 20 inches to 60 inches, lay between 5,000 to 7,500 ft msl elevation, and occur on moderately steep (25 to 60 percent) to very steep (60 to 80 percent) slopes. This fire group is found on all aspects but is most prevalent on north slopes. Frequently this fire group occurs in association with Fire Group Seven.

Engelmann spruce is usually a major component of seral stands along with lodgepole pine and Douglas-fir. Older stands are usually dominated by subalpine fir and spruce although Douglas-fir and lodgepole may be well represented in the overstory. Notable exceptions to this general pattern of species composition occur within the subalpine fir/bluejoint (ABLA/CACA) habitat type which is too wet for Douglas-fir, and within the spruce/common horsetail (PICEA/EQAR) habitat type, where spruce is usually the only successful conifer. Whitebark pine occurs either accidentally or on some sites as a minor seral species.

Abundant undergrowth occurs on these moist sites.

Section 2.10.1 **Forest Fuel**

Fire Group Nine's fuel are similar to those found in Fire Group Eight. Downed dead woody material on the forest floor averages about 20 ton/acre east of the Continental Divide and about 25 tons/acre on the west side but may be much higher.

A large percentage of the downed fuel is material greater than 3 inches in diameter. The combination of deep duff and large accumulations of dead rotten fuel can result in severe surface fire during unusually dry moisture conditions as was experienced within the Scapegoat Wilderness in the later part of 1988. Where dense understories exist, such fires can easily spread to the tree crowns and destroy the stand. Where severe surface fire does not crown, there is a good chance the overstory trees will be killed by cambium heating.

Under normal moisture conditions for these sites, a lush undergrowth of shrubs and herbs usually serves as an effective barrier to rapid fire spread.

Section 2.10.2 **Role of Fire**

Fire history information for moist, lower subalpine habitat types is limited. Mean fire-free intervals are probably longer than those of the drier upland sites in Fire Group Eight.

Sneck (1977) studied the fire history within the subalpine fir/queencup beadlily (ABLA/CLUN) habitat type at Coram Experimental Forest in northwestern Montana. Mean fire-free intervals were found to vary with topography: intervals of greater than 117 years in valleys, 121 years on mountain slopes, and 146 years on lower alpine slopes. The average of these intervals is 128 years. Fires at Coram were reported to be small, moderate severe surface fires that occasionally crowned, especially near ridgetops. These fires thinned stands and prepared a mineral seedbed for conifer regeneration. Small, moderate severity fires are typical at Coram, which is mesic and has discontinuous fuel. Infrequent, widespread, severe fires have been documented for the somewhat drier surrounding habitats (Sneck 1977, Arno 1980). In Kananaskis Provincial Park in Alberta, Canada, stand-replacing fires were found to have occurred at average intervals of 90 years in relatively moist, lower subalpine types composed of subalpine fir, spruce, and lodgepole pine (Hawkes 1979). Relatively long fire-free intervals have been reported for spruce-fir forests on the Medicine Bow National Forest in southwestern Wyoming. Romme and Knight (1981) reported average fire-free intervals of 350 to 400 years in moist drainage bottoms, 300 years for the drier lodgepole pine covered upland sites. Freedman (1983) studied fire history within the ABLA/CLUN habitat type and PICEA/CLUN habitat type in the Goat Creek area of the upper Swan Valley near Condon, MT. Collectively these moist sites had adjusted fire-free intervals (Arno and Peterson 1983) of about 30 years before 1905, with extremes between

10 and 100 years (Freedman and Habeck 1985). Freedman's study sites contained abundant ponderosa pine, which may account for the rather high fire frequencies.

The impact of fire on Fire Group Nine sites in the Scapegoat Wilderness is indicated by stand condition and species composition. The general absence of spruce, subalpine fir climax condition is evidence of disturbance by past fires. The dominance of lodgepole pine, Douglas-fir, spruce, and larch west of the Continental Divide on many sites suggests these stands developed on a fire-created mineral soil seedbed.

The frequency of low severity surface fires in Group Nine is difficult to surmise. The moist nature of these sites would limit the opportunity for such fires in most years to a brief period during the summer or early fall. It seems reasonable to assume that lightning did in fact start such fires and that a certain amount of fuel reduction was accomplished. Left undisturbed, these fires probably flared up occasionally and created openings that favored establishment of seral species.

Section 2.10.3 **Generalized Forest Succession**

The general pattern of succession for Fire Groups Eight and Nine forests is quite similar. Both groups share many of the same seral and climax species, and so have much the same fire response. The two groups are primarily distinguished by the frequency and severity of fire.

In theory, the drier habitat types (Fire Group Eight) should have more frequent fires, particularly those of low to moderate severity. These fires would maintain stands in a seral condition. Because of their moist conditions, habitat types in Fire Group Nine should have lower fire frequencies. the relative high fuel loadings of both live and dead fuel, combined with periodic summer drought, increase the chance for severe, stand-replacing burns when fires do occur.

The potential climax forest would be composed of pure stands of subalpine fir and spruce. The climax situation on any of these sites requires a long time to develop and, consequently, is rarely found. The near climax condition is more common. It is often characterized by a dense understory of subalpine fir and spruce, while Douglas-fir, lodgepole pine, and often spruce form the overstory. West of the Continental Divide, larch may be the dominant overstory species.

A stand-destroying fire in the climax or near climax stage results in an herb/shrub stage (subsequent numbers in this section refer to figure 9). Seedlings and saplings may be Douglas-fir, lodgepole pine, larch, or spruce. Species composition varies with site conditions. Douglas-fir or lodgepole pine frequently dominate. Whitebark pine seedlings occur as accidentals, and some subalpine fir may be present in the initial stand.

Any fire in the seedling/sapling stage reverts the stand to the shrub/herb condition (No. 2). Moderate fires in pole-sized stands (No. 3) will favor the more resistant Douglas-fir, or larch over lodgepole pine, spruce, or subalpine fir. A severe fire (No. 4) destroys the stand. Where serotinous lodgepole pine is present, seedlings of this species form a pure or nearly pure stand.

In the continued absence of fire, a mature stand develops. Lodgepole pine, Douglas-fir, and larch dominate the overstory, beneath which is a dense understory of subalpine fir and spruce. A low severity fire (No. 5) removes this understory and some of the lodgepole pine, thereby favoring the reproduction of Douglas-fir and larch.

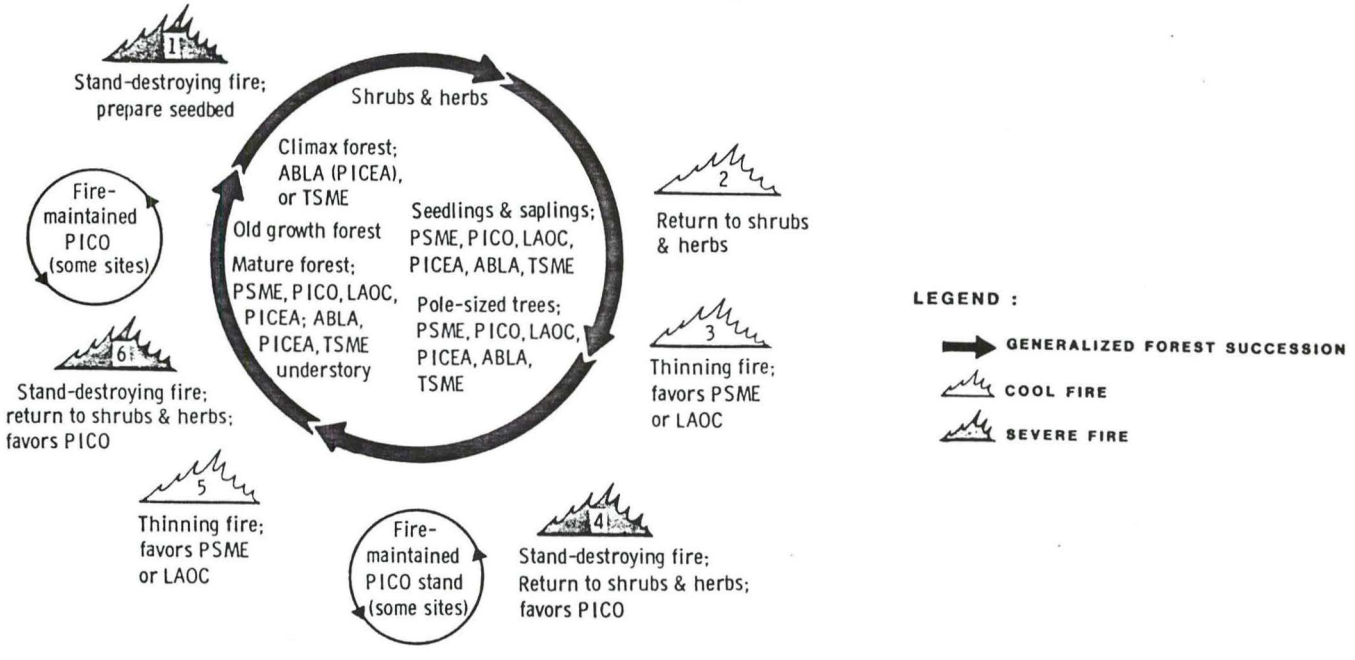


Figure 9. Generalized forest succession in Fire Group Eight: dry, lower subalpine habitat types; and in Fire Group Nine: moist, lower subalpine habitat types (after Fischer and Bradley 1987).

A moderate or severe fire could remove much of the Douglas-fir, leaving the site to be regenerated by either serotinous lodgepole pine or remnant larch. Some severe fires remove even the fire resistant larch. In this case, or where there are severe fires in near climax stands, the site returns to a treeless condition (No. 6). If fire does not occur for a long time, the near climax stand may develop to the climax state, although a fire-free interval of this length is unlikely.

In each stage of stand development discussed, Fire Group Nine sites have less chance of burning than those in Group Eight because of their generally more mesic conditions.

In 1901, Ayers described the forest succession within this fire group as he observed it a few years earlier within the Lewis and Clark Forest Reserve:

> "The severe fires below 6,000 feet have been followed by lodgepole pine where restocked at all, but the moderate fires in the lower altitudes and all those in the higher altitudes have usually been followed by a mixed growth in which spruce predominates. Many of the severe old burns that have been restocked have at first been covered with lodgepole pine, under which spruce, white pine, larch, balsam, and other shade-enduring trees have sometimes started. A very dense stand of the original stock, however, does not readily admit other species, and lodgepole pine in such cases is apt to remain until the trees begin to die of old age.
>
> Moderate fires may thin out the species most sensitive to fire and leave those protected by thick bark. A notable instance of this was found in the upper portion of the Swan River Valley, where a mixed stock of larch and lodgepole pine had been run through by light fires, which killed the thin-barked lodgepole pine, but left the thick-barked larch but slightly injuried."

Section 2.11.0 FIRE GROUP TEN: COLD, MOIST UPPER SUBALPINE AND TIMBERLINE HABITAT TYPES

Fire Group Ten consists of high-elevation forests near and at timberline. About ten percent of the Scapegoat Wilderness and adjacent Danaher portion of the Bob Marshall Wilderness are in Fire Group Ten (USDA 1981). All stands lie above the climatic limits of Douglas-fir and many stands are above the cold limits of lodgepole pine. Subalpine fir is the indicated climax species, whitebark pine and Engelmann spruce are long-lived seral species. Lodgepole pine occurs on some upper subalpine sites. Landforms within the wilderness where Fire Group Ten is found include glacial cirque basins, forested high elevation ridges, and sparsely vegetated peaks and alpine ridges. Except for the side slopes and rounded high elevation ridges, these landforms frequently include scree and barerock with only limited forested areas. Elevations can range from 6,000 to 9,200 ft msl, and slopes commonly range from 25 to 60 percent or greater. These high elevation sites have a wide range of annual precipitation from 25 inches in the east to greater than 80 inches in the west of which 60 to 80 percent arrives as snow. Snows arrive early in fall and commonly stay late into mid-summer. Temperature inversions may extend the growing season at some locations. Localized inclusions of Fire Group Nine occur.

Timberline habitat types support stands composed of subalpine larch, whitebark pine, Engelmann spruce and subalpine fir. Trees characteristically grow in groups with open areas in between. Competition due to differences in tolerance is not as pronounced at timberline as it is in lower forests. Habitat types at these high elevations are named for their dominant tree component rather than an indicated climax species.

Undergrowth in the upper subalpine habitat types is usually composed of only a few important species, and in timberline habitat types undergrowth occurs in mosaics.

Section 2.11.1 **Forest Fuel**

Fire Group Ten sites are characterized by relatively sparse fine fuel and moderate to heavy loadings of widely scattered large-diameter fuel. Fuel data from eastside National Forests in Montana show an average of about 2 tons/acre of small diameter materials between 1/4 inch and 3 inches in size. These figures agree with those reported for Group Ten sites in the Selway-Bitterroot Wilderness (Davis and others 1980). Brown and See (1981) reported an average downed woody loading of about 18 tons/acre from Western Montana forests. This value includes fuel larger than 3 inches in diameter and again is similar to data collected from the Selway-Bitterroot Wilderness.

The downed and dead woody fuel loadings often take the form of scattered large-diameter downfall resulting from wind and snow breakage, windthrow, and mortality caused by insects and disease. Such heavy fuel particles do not necessarily reflect a serious fire hazard. The mitigating effects of the normally cool, moist site, the typically short fire season, and the usually sparse and often discontinuous nature of fine surface fuel particles must be considered when evaluating overall fire potential.

Section 2.11.2 **Role of Fire**

Fire is secondary to site factors (climate and soil) as an influence on forest development on these sites. The cold moist, rocky, snowbound, unproductive, and otherwise fire-resistant environment that characterizes many of the sites not only makes fires infrequent but severely limits their areal extent. Lightning does ignite fires, but the paucity of continuous fine surface fuel coupled with the rain that commonly accompanies thunderstorms usually limits fire spread and severity. Historical fire frequencies ranging from 35 to 300 years have been reported for individual sites (Romme 1980). Such figures are difficult to interpret because a fire may involve only one or two trees in a stand. For this reason the concept of fire frequency does not apply well in upper subalpine and timberline sites.

In more continuous forests of this group, the most pronounced fire effect is to produce stand-replacing fires at long intervals, perhaps 200 or more years in most cases. Stand destroying fires are most likely to occur during extended drought conditions when severe wind-driven crown fires develop in the forests below and burn into the upper subalpine and timberline forests. These are the types of conditions which repeatedly drove the Canyon Creek Fire in the Scapegoat Wilderness through Fire Group Ten habitat types in 1988. Similar conditions probably existed when many fires in 1889 burned throughout what was then termed the Lewis and Clark Reserve and would later become the Bob Marshall Wilderness complex, and in particular the future Scapegoat Wilderness portion of the complex.

Tree recovery following such fires is usually slow because of the extremely short growing season and cold climate. Arno (1984) reported reinvasion of whitebark pine on timberline sites in the Bitterroot Mountains 50 to 200 years after fire. Based on his observations in many upper subalpine habitat types, Arno (1986) suggests that fire has been important in perpetuating an abundance of whitebark pine.

Section 2.11.3 Generalized Forest Succession

Secondary succession begins with a mixture of herbs and shrubs (figure 10). It is likely that herbaceous plants will dominate for an extended period. Fire may initiate secondary succession, but it is unlikely that it has a role in maintaining it. Physical disruption of the stand by snow and wind, rock slides, and talus slippage is more important on moist sites and north slopes than is fire in maintaining early stages of succession.

It takes a long time before conifers dominate some site, perhaps 100 years. It may take another 100 years before a mature forest exists. It is unlikely that fuel or stand conditions will support a fire of any consequence during this period. Surface fires do occur, especially in whitebark pine stands on south slopes and ridges. Such fires act as underburns, reducing fuel and killing some overstory trees. Severe fires within Fire Group Ten forests may occur over small areas, but their effect will usually be limited to the creation of vegetation mosaics. During periods of extended drought when severe fires have the opportunity to burn up out of lower elevation forests in to Fire Group Ten the effects can be on a much larger scale. Even though surface fires may carry into group ten to a limited extent, hot gasses contained in the convection column from the burning forest below may adhere to the upper slope causing tree mortality through crown scorch. West and southwest aspects are particular susceptible to this type of convection column behavior during wind-driven fires. This was the principal cause of mortality within the Fire Group Ten forests during the 1988 Canyon Creek Fire which covered large group ten areas in and near the Scapegoat Wilderness.

Given a sufficient period of disturbance free time, a mature forest will develop. These forests will begin to break up under the impact of wind and snow breakage, windthrow, mortality caused by insects and disease, and senescence. Without disturbance the mature trees will progress into a climax stand. This advanced successional stage requires decades, possibly two or three centuries. Low to moderate severity fires rarely have a significant impact on a mature stand because of the open structure and lack of continuous fine fuel. However, severe fires will return the site to the early successional stages.

Section 2.12.0 Scapegoat Wilderness Fire History

Little indepth fire history work has been accomplished within or near the Scapegoat Wilderness. Gabriel (1976) studied the fire history of the Danaher Creek drainage which is across a minor divide that separates the Scapegoat and Bob Marshall portions of the wilderness complex. This is the only study which uses the methods of Arno and Sneck (1977) to date fires using scars on tree boles. Information from Gabriel's study can be used to gain an understanding of potential fire frequencies in the adjacent Dry Fork of the North Fork of the Blackfoot River portion of the Scapegoat Wilderness.

Interpretation of the fire/vegetation related comments, maps, and photographs recorded by Ayers (1901) during his 1899 field season in the Lewis

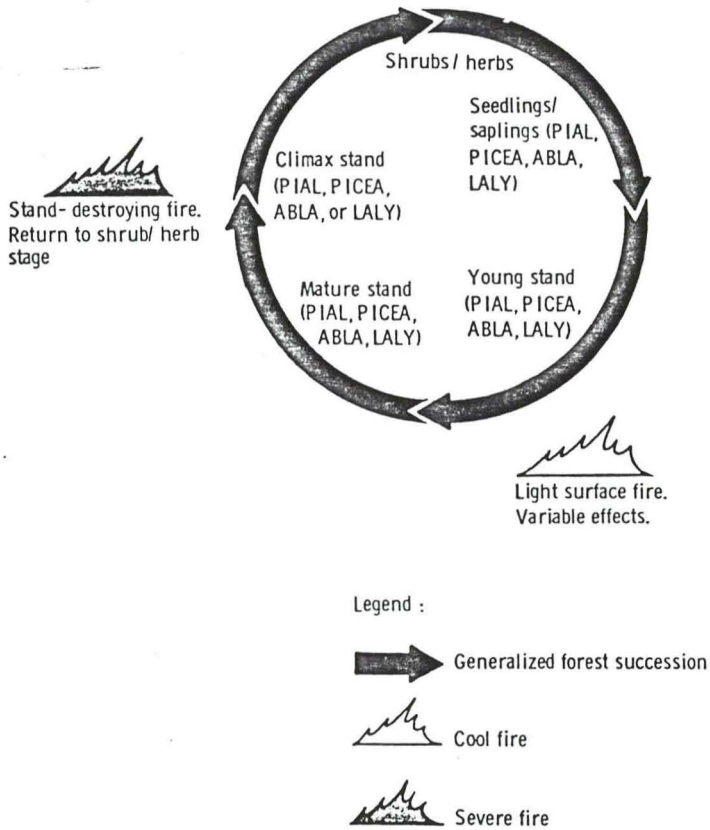

Shrubs / herbs
Seedlings/ saplings (PIAL, PICEA, ABLA, LALY)
Young stand (PIAL, PICEA, ABLA, LALY)
Mature stand (PIAL, PICEA, ABLA, LALY)
Climax stand (PIAL, PICEA, ABLA, or LALY)
Stand- destroying fire. Return to shrub/ herb stage
Light surface fire. Variable effects.
Legend :
Generalized forest succession
Cool fire
Severe fire

Figure 10. Generalized forest succession in Fire Group Ten: cold, moist upper subalpine and timberline habitat types. Low-severity lightning fires may occur at any stage with little effect on succession (after Fischer and Clayton 1983).

and Clark Reserve contributes valuable information to the recent fire history of the Scapegoat Wilderness. Ayers's and Gabriel's work in conjunction with panoramic photographs taken during the 1930's and 40's from fire detection lookouts established in and near the wilderness, and USDA Forest Service Fire Atlas's for the area help define the impact of fire during the last century.

Gabriel (1976) found that the southern half of the Danaher Creek drainage which was the closest portion of his study area to the Scapegoat Wilderness and the Canyon Creek Fire; in the Douglas-fir and spruce-subalpine fir zones at low to mid-slope elevations (Fire Groups Five - Nine), had a history of frequent surface fires creeping through lodgepole pine stands. These fires left many surviving trees, of which only a small percentage was burned severely enough to leave a fire scar. However, using this record for the area he was able to record a history of repeated fire occurrence back to the year 1749. Data from trees with multiple fire scars indicates that fires occurred at 20 to 40 year intervals in each lodgepole pine stand during the period from 1749 to 1944. Old stands of Douglas-fir recorded fewer fires which occurred in 1809, 1847, and more severe fires in 1854 and 1889, followed by another low to moderate severity fire in 1910. One Douglas-fir stand on the west slope of Concord Mountain, adjacent to the Scapegoat Wilderness, apparently burned four times within thirty years (1889, 1895, 1910, and 1919).

Burned stumps and a few old Douglas-fir trees on the divide between Danaher Creek and the Dry Fork of the North Fork of the Blackfoot River indicated that a fire about 1870 killed many of the trees in that stand and the fire of 1889 removed the rest. One hundred year old lodgepole pine now occupy the pass and carried scars from fires in 1910 and 1919.

Gabriel found only one area in the southern half of Danaher Creek which did not have any evidence of fire occurrence. This was a 240-280 year old mixed stand of Engelmann spruce, subalpine fir, Douglas-fir and lodgepole pine on the north flank of Danaher Mountain. Over the rest of his study area there was evidence that fires had changed the species and age composition of extensive forested areas in 1809, 1844-47, and 1889; fires in 1854-59, 1895 and 1910 probably had similar effects but on a smaller scale.

At higher elevations in what Gabriel also called the spruce-subalpine fir zone (probably Fire Group Ten) he found abundant evidence of fire in the form of charcoal and dead snags. Fire scars were found in alpine larch, whitebark pine, and limber pine. He found that during the years 1809, 1847, 1919, and 1926 when large fires occurred at lower elevations they also burned in higher elevation sites. There was also evidence of numerous small fires at high altitudes.

Only the fires of 1889, 1910, and 1919 in the Danaher Creek drainage still had evidence existing that they had crossed the divide either into or from the Dry Fork of the North Fork of the Blackfoot River. Prior to the fires of 1844 insufficient evidence was available to even define rough fire boundaries within Danaher Creek, just occasional fire scars on old trees to show that a fire had occurred. However, since the two drainages on either side of the divide have similar climatic patterns and Fire Groups we can assume that they had similar fire histories. Especially when numerous or extensive lightning fires occurred in the Danaher Creek area, there were likely fires across the divide in the Dry Fork as well.

Gabriel found that more evidence existed for the extent of the 1889 fires, than for any others, before or since. Evidence for this fire year was not only evident from fire scars but also from visible changes in forest height (age) and species composition. These fires also made it difficult to determine the boundaries of earlier fires, especially those of 1895, which may have reburned

portions of the 1889 fires cleaning up dead and down woody fuel and recently established tree regeneration. The 1910 fires within this drainage also reburned some of the same areas for a third time and the only direct evidence for the 1895 fires was a few trees growing in protected locations that the later fires missed. There were also some areas of regeneration established shortly after 1885 that later fires did not burn.

During 1899 Ayers travelled through and described extensive portions of the 1889 fires. He also mapped burned areas which he saw had been "severe enough to kill all, or nearly, all the trees" during what he estimated to be the previous forty years. Older fires had lost the features which distinguished them from the rest of the landscape as the regenerated forest gained in height. Low or moderate severity fires which did not remove the forest canopy were not mapped as burned, but as timberlands. In some areas Ayers mentioned that fires of this type were common. Ayers estimated that approximately 1,420 square miles had burned within the Lewis and Clark Forest Reserve and another 380 square miles adjacent to the Reserve for a total of 1,800 square miles during that forty year period (approximately 1860-1900). Of that total about 1,200 square miles burned in 1889.

> "That year was said to have been exceptionally dry, and the smoke from the forest fires almost unendurable. ... The fires have varied through all degrees of intensity. The severest have rushed through the tree tops consuming the needles and smaller twigs and igniting the humus lying upon the surface, which, even when burning slowly, has made fire enough to consume the smaller roots that were in the humus. The fires of 1889 were generally of this sort". (Ayers 1901)

As can be seen from his map much of the area now named the Scapegoat Wilderness was mapped as burned. An area much greater than the 1988 Canyon Creek Fire.

Ayers map of the Reserve can be considered a rough approximation of the burned boundaries (figure 11). He only spent four months inside the Reserve doing the mapping, travelling on horseback through the principal drainages and to high vantage points to view the distant topography. However, in spite of his lack of "hi-tech" methods his fire boundaries do match fire patterns discernible from panoramic photographs taken from fire detection lookout stations in the 1930's and early 40's. These being the lookout stations at Falls Point, Center Ridge, and Stonewall Mountain. These photographs also show older forest within the burn patterns, small drainages missed or underburned by the fires which Ayers simply included as burned because of their small extent. Ayers broke his study area up in to major drainage patterns, for the area east and along the Continental Divide drained by the Missouri River he wrote concerning the 1889 fires:

> "The fire of 1889, which seems to have run over most of this area, occurred during a very dry time, and most of the ground over which it ran has only dead trees and a very small amount of humus left. Within this area the fire covered about 530 square miles, most of which is now bristling with dead trees, except in places previously burned. On such places nearly all material has been consumed. A previous fire

covered an undetermined area, the signs of it being on much of the ground, obliterated by later fires. On some 50 square miles, principally along the Continental Divide, plain evidence of the fires of this period remain. The dead trees and stubs left by these fires are better preserved in the high altitudes than in the valleys, as, being more isolated, they have partially escaped the later fires, which, on the foothills bordering the plains, have obliterated nearly all traces of the forest they have destroyed. Only occasional stubs and roots remain in the grass or brush".

The Blackfoot River drainage Ayers included with his discussion of the South Fork of the Flathead River:

"On the Blackfoot drainage about 175 square miles, and on the South Fork of Flathead inside the reserve about 310 square miles, and outside of the reserve 10 square miles, have been burned over severely. Most of this area was burned, some of it for the second time, in 1889. All the burns indicated on the map (Pl.III) have been severe, and very few trees are left on these areas. They frequently have a network of fallen trees, among which some dead trees remain standing. Most of the humus has been burned off, and the earth is left bare".

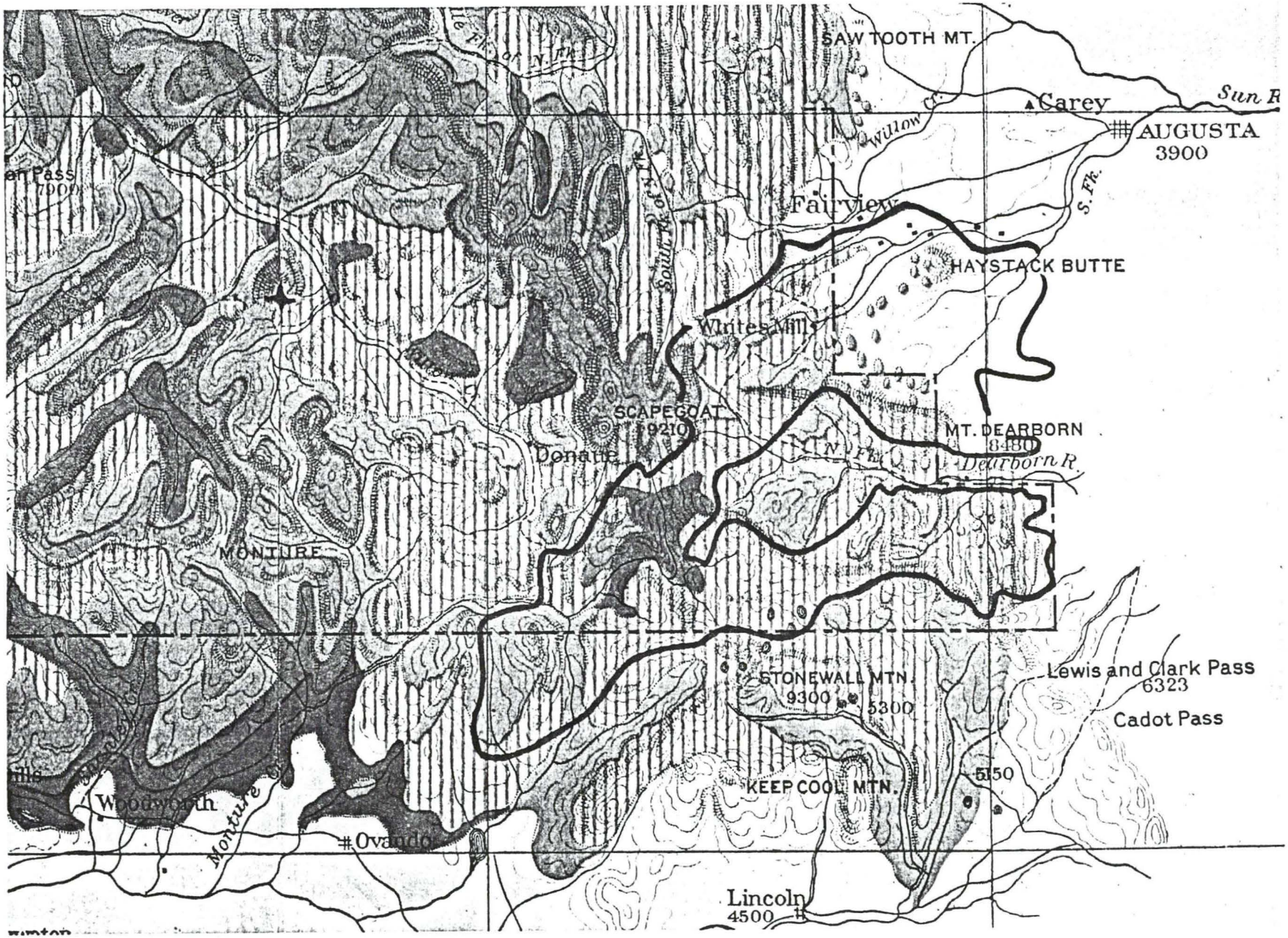
He also mentions in other locations that there was evidence of many burns dating about 1860 (Gabriel had recorded large fires in 1844 and 1854) which had reburned in 1889.

The 1889 burned area to have covered such a large piece of very rough topography had to have been caused by multiple ignition sources. Many of the resultant ignitions later merged as the free-burning fires grew in size during the long fire season and under wind events. The 1889 fires in the Scapegoat Wilderness area burned from the Monture Creek-Fenn Mountain area east onto the plains through the Dearborn River, Elk Creek, and Falls Creek Drainages. The fires extended south down Silver King Mountain, Stonewall Mountain, Arrastra Mountain areas; and almost all of the timbered area south of Lake Creek toward Kleinsmith Flats. The 1988 Canyon Creek Fire (approximately 376 square miles, falls within the larger 1889 pattern and exited onto the eastern plains down the same drainages 99 years and 5 days after the earlier fire. Both fires burned into the eastern plains under strong wind events (Howard, 1938; Appendix xx). It is interesting to note that Ayers shows several large unburned areas to the east of Crow Mountain along the Dearborn River Drainage which evidently did not burn in either 1889 or in 1988. The head of the North Fork of the Blackfoot River to the south of Tobacco Valley was also missed by both fire years. Other large areas not indicated as burned in 1889 but which did burn in 1988 included the North Fork of the Blackfoot River drainage to the east of Falls Point and Evans Peak, and the north aspect of Lake Mountain down to the Dry Fork and Canyon Creek.

Gabriel (1976) found that Forest Service historical records for his study area showed less acreage burned by fires in 1889, 1910, and 1926 then his investigations indicated. Also the 1919 fires in the Danaher Creek drainage were not indicated on the Forest Service maps. This illustrates some of the

Figure 11. Enlarged detail from the lower right-hand corner of Ayers (1901) map of the Lewis and Clark Reserve. This map shows the present day Scapegoat Wilderness and surrounding region as it appeared in 1899. The 1988 Canyon Creek Fire has been outlined on the map to show the approximate extent of that fire and its relationship to burned and unburned topography as viewed by Ayers. Some distortion of the Canyon Creek Fire perimeter has resulted by trying to match forest burned or missed with the placement of physical features on Ayers's map. Of particular interest is the extend of canopy replacement fire in the coniferous forest in the forty years preceeding 1899. Much of the burned landscape on Ayers's map in this region can be attributted to the 1889 fires much of which reburned areas previously burned in early decades. Scale is approximately 1 inch = 8 miles.

Legend: Verticle Lines = Burned landscape within the previous +/-40 years.
Olive = Forested area with less than 2000 M. boardfeet per acre.
Green = Forested area with 2000 - 5000 M. boardfeet per acre.
Dark Green = Forested area with 5000 - 10000 M. boardfeet per acre.
Yellow/Orange = Prairie or areas dominated by native grasslands.
Grey = Bare summits (rock).


SAW TOOTH MT.
Carey
Sun R
AUGUSTA
3900
Willow Cr.
S. Fk.
Fairview
HAYSTACK BUTTE
South Fk. of N. Fk.
Writes Mill
SCAPEGOAT
9210
MT. DEARBORN
8480
Dearborn R.
Donan
MONTURE
STONEWALL MTN.
9300
5300
Lewis and Clark Pass
6323
Cadot Pass
5150
KEEP COOL MTN.
Woodworth
Ovando
Monture Cr.
Lincoln
4500

difficulties using Forest Service Fire Atlas maps as an accurate indication of the extent and occurrence of backcountry fires. The Fire Atlas's from the Lolo National Forest show fires in 1910 on the east slope of Fenn Mountain to the west of the Scapegoat Wilderness, which reburned some of the 1889 fire. Fires in 1919 are shown again to the west of the wilderness the closest approaching the wilderness in the Lake Otatsy area. The only fire within the wilderness boundaries shown on the Lolo Fire Atlas was in 1952 (North Fork Fire) south of Falls Point which burned approximately 494 acres. Since that 1952 fire only one other large fire has occurred, the 1,389 acre Cabin Fire which occurred in 1979 along the East Fork of the North Fork of the Blackfoot River. Both the 1952 and 1979 fires were man caused. A small lightning caused fire in 1955 also occurred near Canyon Point (USDA, 1981) and is unmapped. The 1910-1930 Fire Atlas from the Lewis and Clark National Forest included the northern portions of the present day Helena National Forest. This atlas showed very limited fires in 1919 (38 acres) and 1920 (72 acres) in or near the present day Scapegoat Wilderness. In 1929 two fires burned 3,323 acres in the lower portion of the Dearborn River drainage in an area missed by the 1889 fires. Fire atlas's after 1930 were not available from the Lewis and Clark National Forest. However, it is known that a fire occurred in the Green Fork of the Halfmoon Unit in 1936 and burned approximately 3,500 acres (USDA, 1981). No boundaries were located for the Green Fork Fire and it is not included on the Scapegoat Wilderness and adjacent areas fire history. All indications are that there has been very little fire occurrence in and near the present Scpaegoat Wilderness since the 1889 fires even with possible inaccurate fire atlas records. In the 60 year period of record between 1919 and 1979 an estimated 5315 acres were burned in the Scapegoat Wilderness.

Since at least 1899 when Ayers reported that "several fires had been put out by the forest rangers", fire suppression has restricted the number of fires throughout the Northern Rocky Mountains. It is thought that even through some of the early fire detection and fighting techniques may have been primitive by todays standards, they were efficient enough to essentially eliminate fire as an ecological force in the backcountry. Active fire suppression and several decades of relatively moist weather prior to the beginning of the prescribed fire program in the Bob Marshall Complex in the early 1980's, have combined for a relatively long fire-free low to moderate severity fire interval in many Fire Groups which have historically burned more frequently than the 99 years between 1889 and 1988. However, the occurrence of severe stand-replacing fires have occurred well within, and almost on schedule for the known fire history within the widespread Fire Groups Seven and Nine. The lack of low to moderate severity fires may have contributed to the severity of the 1988 Canyon Creek Fire, but a natural fire frequency prior to 1899 evidently did little to limit the extent and severity of that particular fire year.

Since evidence of fire history in the Scapegoat Wilderness was largely removed by the wide ranging 1889 and 1988 fires it is difficult to speculate on the occurrence of previous large fires in this area. However if two have occurred within 100 years it seems a reasonable extension to speculate that similar fires have occurred prior to the 1889 fire. In fact it seems plausible that the fire years of 1844 and 1854 in the Danaher drainage may also have resulted in fires in other portions of the Scapegoat Wilderness. Ayers (1901) mentions that some of the 1889 fire area he traveled through within his South Fork Valley of the Flathead River and the Blackfoot River study area had been burned for the second time. He does not mention specific locations, nor does he provide us with any idea on the extent of the reburned area.

I would like to propose a possible scenario of some extensive drainage wide burning prior to the 1889 fires for the Scapegoat Wilderness on both sides of the Continental Divide. Fuel load measurements done prior to development of the Fire management Plan for the wilderness found that many of the drainages burned in 1889 had relatively light surface fuel loads prior to the 1988 fire. Loadings of 4 to 12 tons per acre were common within the larger east-west oriented drainages, drainages oriented with the westerly prevailing winds and likely prone to more frequent fires events. Most of these east-west oriented drainages (such as Tobacco Valley, Cooney Creek, lower Canyon Creek, portions of Mineral Creek) developed a mature overstory of Fire Group 7 and 8, fuel model 9 lodgepole pine following the 1889 fire season. These inventoried fuel loading values are on the light side for both Fuel Group 7 and 8, especially if the areas had within the last 100 years experienced alot of fallen dead timber killed by the 1889 fires. Fires which likely occurred sometime during the 1840 to 1875 period (areas burned after 1875 would most likely have had insufficient new growth to provide a uniform enough fuel bed to sustain a high intensity fire front) and which were not as extensive as the 1889 and 1988 fires but still covering large expanses of land principally in the east-west oriented drainages would have created extensive beds of heavy dead and down fuel. After these fires, a young cohort of new trees became established growing up through the dead and down materials. Very similar to what will happen following the 1988 Canyon Creek Fire, except on a more limited scale. When the 1889 fire occurred and reburned these drainages with young tree growth, the fuel loads were removed and the young trees killed. The small size of the newly killed trees and remaining residule charred dead and down fuel resulted in extensive areas of reduced fuel load. These previously twice burned drainages then produced a mature forest of relatively even aged trees on a nearly clean forest floor. Nearly 100 years of slow decomposition would reduce this fuel bed even further, resulting in the 4 to 12 tons per acre of dead and down biomass observed prior to the 1988 fire. Other areas burned in 1889 that did not have these proposed 1840-1875 fires, or which were missed in 1889, developed heavier dead and down fuels much of which later burned during 1988 (20 to 56 tons per acre within the Scapegoat, 20 to 126 tons per acre outside the Scapegoat Wilderness and beyond the southern perimeter of the 1889 fires on the Lincoln Ranger District). So a pattern of at least three large fires regimes emerges, with the first regime possibly occurring over more than one burning season. The first regime killed standing timber and created a heavy dead and down fuel bed, the second series of fires in 1889 then killed the newly established young trees and removed the accumulated heavy fuels from the previous fire regime, and the third fire in 1988 burned through these mature forest drainages with light surface fuel creating another cycle of heavy dead and down fuel loading.

The immediate forest and fuel succession future on the west side of the divide and within the Canyon Creek fire perimeter can follow two potential patterns for the immediate near future. The first pattern that could be possible is another era of limited fire occurrence due to either an extended period of moist fire seasons with an increased amount of fire suppression during periodic dry years, or another period of near total fire suppression. Either possibility would eventually result in a similar amount of burned acreage as resulted following either the 1889 or 1988 fires. This scenario leads to the eventual return of another large fire event in 70 to 100 years which would burn through extensive areas of very heavy dead and down fuel loads over which had developed a mature, thick forest canopy covering potential natural fire barriers. The second potential pattern for the future results in periodic drainage wide fires after live fuel loads are again sufficient to

again carry fires. These fires would result from the continued occurrence of periodic dry fire seasons and the continuation of wilderness prescribed natural fires. Fires of limited extent may within a few years (five to ten years postburn) be again possible in areas of good herbaceous, brush and young tree growth. Most areas will take considerably longer to accumulate sufficient fuel to sustain a fire front; possibly somewhere between nine years as was the case with the Cabin Fire which didn't burn in 1988, and 36 years the age of the North Fork Fire of which portions did reburn. Until these drainages again develop a forest canopy mature enough to either spot or carry a crown fire across ridgetops the fires will be restricted to one, or possibly a few adjacent drainages. The many ridgetops exposed by the 1988 fire should provide many good fire barriers which were not available during that particular fire season. These future fires would reduce dead and down fuels from the 1988 fire and eventually result in drainages of mostly regenerated single aged vegetation, and create a multi-aged landscape. Even under this potential pattern the possibility of a large acreage fire in the Scapegoat Wilderness eventually returns with the gradual maturing of vegetation. With the limited occurrance of lightning caused fires which typically occur within the Scapegoat Wilderness the eventual development of a widespread mature forest overstory may be a natural feature of the system. With large scale wind events, or multiple smaller wind events and a limited amount of effective naturally occurring fire barriers under a mature forest canopy, fires would again move from west of the Continental Divide to the east side until an end of the fire season weather event happens.

Section 3.0.0 Climatology

In general the climate of the Scapegoat Wilderness can be described as short, dry, summers with moderate temperatures and cool nights usually restricted to July-August; autumn (September-October) comes early and is distinctly a transitional season; winter (November-February) is normally cold and the wettest season; spring is another transitional period with numerous cool, stormy periods and doesn't seem to really arrive until June. Shower activity during this spring period may be almost daily and is commonly mixed with snow, especially at the higher elevations. The broken, mountainous topography of the area supports a continuum of climatic changes with differing combinations of altitude, slope, and aspect. The snow in the valleys usually disappears between April and May, but may remain at the higher elevations until late July. May and June are moderately wet months followed by dry summer and fall months.

West of the Continental Divide of the Northern Rocky Mountains, Montana has a moderate and moist, maritime climate which is influenced more by air masses from the Pacific Ocean. East of the divide the climate is predominately influenced by the continental climate and experiences the extremes of summer heat and winter cold. The Scapegoat Wilderness which straddles the divide is an area transitional between the Pacific maritime and continental types, on which there is superimposed the influence of mountain-climate characteristics. The Pacific influence is noted principally during periods of late autumn and winter maximum cloudiness (up to 70% of the potential maximum sunny period at Missoula, MT) and precipitation. Also with the relatively moderate average temperatures compared with the continental type further east of the divide. Winter temperatures are especially variable on the side east of the divide, as arctic airflow alternates with warm, downslope winds (chinooks) occurring with Pacific air-flow. Summer is generally sunny (during July the sunshine averages about 80% of the potential maximum sunny period at Missoula, MT) and dry. July and August are the peak historic fire months but may extend into the fall during exceptionally dry late seasons, especially east of the divide. West of the divide July through October is typically the driest period, while further to the east in the adjacent plaines October through March normally constitutes the dry season with July-September being transitional in terms of precipitation.

Storms in the area generally track from west to east following the prevailing flow aloft. Fall-winter storm tracks, usually starting in September, tend to come from the west-northwest; while spring-summer storms usually develop with a west-southwesterly flow pattern. Summer afternoon-evening thunderstorms commonly develop during periods of unstable atmospheric conditions and upper level moisture drawn from central-southern California. These thunderstorms frequently follow the major drainage patterns in their southwest to northeast flow. The Blackfoot River channels much of this air flow from the upper Bitterroot Valley through Ninemile Prairie, and onward toward the Monture Creek drainage pattern which leads right into the Scapegoat Wilderness. Much of the moisture carried by these storms are lost on the intervening mountain ranges before in reaches the Scapegoat Wilderness. Annual precipitation ranges from about 20 inches (50.8 cm) at the lower elevations upwards to 80 or more inches (203.2 cm) at higher altitudes on the west side of the Continental Divide, with 40 to 80 percent arriving in the form of snow. East of the divide annual precipitation is noticeably less ranging from about 20 to 50 inches (50.8 to 127 cm) with 40 to 60 percent as snow (USDA 1980).

Lightning from these thunderstorms is recognized as a principal cause of fires in the Northern Rocky Mountains (Barrows 1951, Barrows and others 1977). Expanding the geographic area to include the southern half of the USFS Seeley Lake Ranger District and all of the USFS Lincoln Ranger District west of the Continental Divide, lightning caused fires have a well defined season (Figure 12). A small precentage (5.7%) of the total lightning caused fires occur in May. By June the percentage of total lightning caused fires from the combined districts only climbs to 10.4%. July's percentage continues to climb as forest conditions continue to dry. Nearly half (49.6%) of the total lightning caused fires from the combined districts occur during the month of August. Percentages for September for the combined districts are the lowest for any month during the season (4.9%). The total lightning caused fires in any particular year is very inconsistant compared to other seasons (Figure 13). In examining the 18 year record (1970-1987) from the Seeley Lake Ranger Station it was found that this area averages 16 lightning caused fires per year. Most years have fewer lightning caused fires than the average with isolated single seasons having much greater than normal numbers of fires on this district. A similar pattern was found on the Lincoln Ranger District were the average number of lightning caused fires per year was 9 (1937-1987).

The number of lightning caused fires which have occurred within the Scapegoat Wilderness appears to be considerably less than the expanded geographic area examined to determine the lightning fire season, but the seasonal distribution is approximately the same. Between 1940 and 1979 the Seeley Lake District reported only 44 lightning caused fires within the wilderness (the Blackfoot Fire Management Unit)(USFS 1981). From 1977, no fires occurred until 1981 when one was reported. The Canyon Point Fire (August 15, 1981) was managed as the first prescribed natural fire on the Lolo National Forest's portion of the Scapegoat Wilderness and ended up being about 2 acres in size. Another gap of two years occurred before the next reported lightning caused fire on the Lolo National Forest's portion of the wilderness. During 1984 there were 4 fires which resulted in spot fires. In 1985 only one fire was managed as a management fire by the Forest in this wilderness and resulted in about 0.25 acres being burned. In 1987 another Scapegoat fire on the Lolo National Forest was managed as a prescribed fire and resulted in 2 burned acres. The only June fires which could have been evaluated on the Lolo National Forest for prescribed natural fires in the Scapegoat occured in 1988. The Canyon Creek Fire approved as a prescribed natural fire, and the Cabin Creek Fire ignited on the same date as the Canyon Creek Fire but which was extinguished by rains before a management review could take place. Within the Scapegoat - Danaher Wilderness Fire Management Plan there is listed a total of 22 lightning caused fires within the Scapegoat portion of the wilderness between 1970-1979, an average of 2.2 fires per year. Looking at the entire Scapegoat Wilderness for the years 1940-1987 a similar record of 137 lightning caused fires were recorded, and eight man caused fires. This 48 year record results in an average of 2.8 lightning caused fires per year of the entire wilderness. During the 1988 season there would be eight lightning caused fires within the boundaries of the Scapegoat Wildernes. Several years may go by without a single lighting caused fire in this area. On only the Lolo National Forest's portion of the Scapegoat there appears to have been 53 lightning caused fires recorded between 1940-1988 (36.5% of the total for the time period for the entire wilderness area), or about 1 fire per year. The lightning caused fires between 1970-1988, not including the Canyon

Figure 12. Monthly percentage of total lightning caused fires for the Scapegoat Wilderness and surrounding portions of the Seeley Lake Ranger District (Lolo National Forest), and the Lincoln Ranger District (Helena National Forest).

Lightning Caused Fires

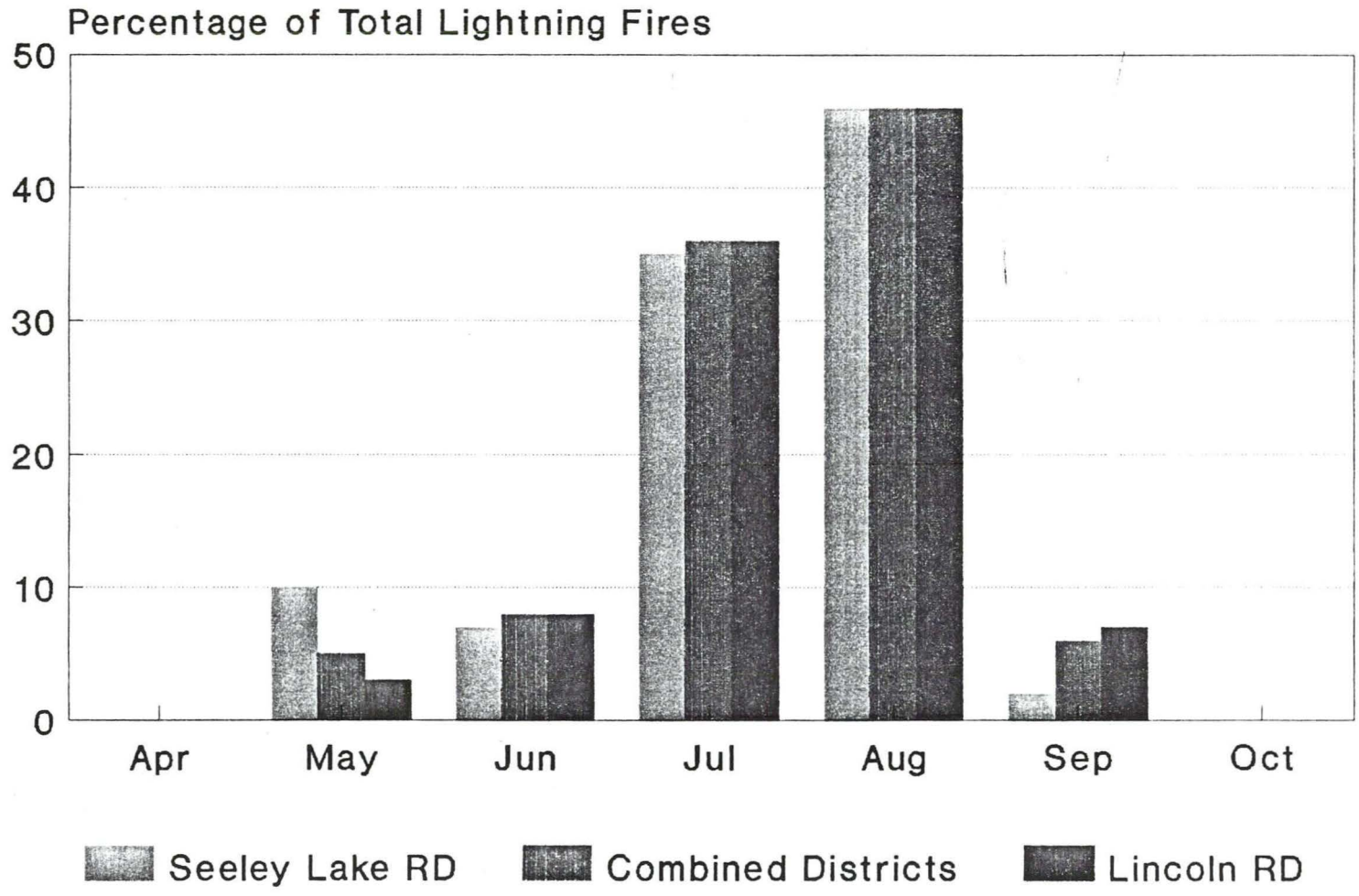
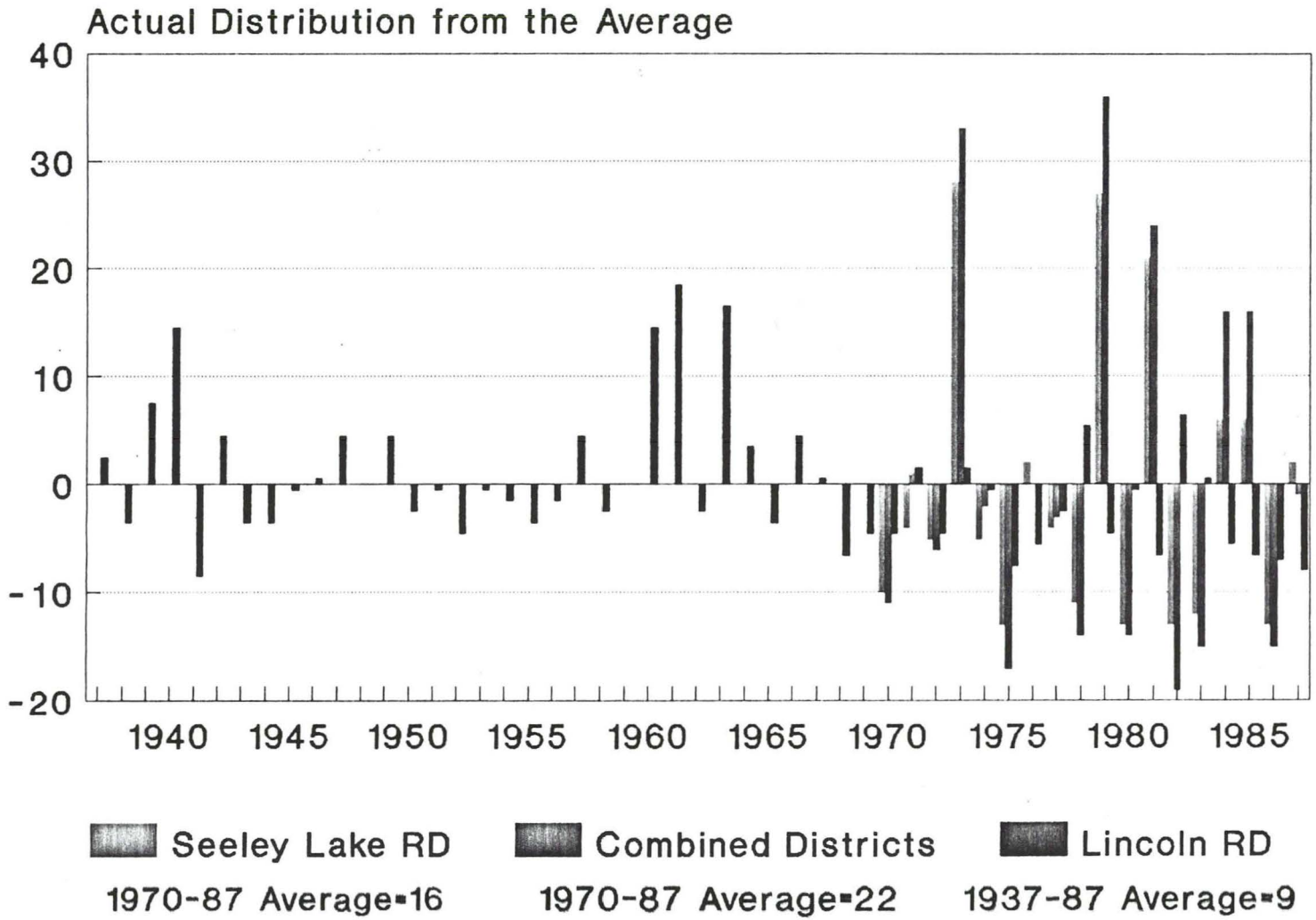


Figure 13. Actual distribution from the average of the annual lightning caused fires for the Scapegoat Wilderness and surrounding portions of the Seeley Lake Ranger District (Lolo National Forest), and the Lincoln Ranger District (Helena National Forest).

Total Lightning Caused Fires



Creek Fire, resulted in less than 5 reported burned acres; about 0.25 acres a year. It appears, and is generally excepted, that the number of lightning caused fires within the Scapegoat Wilderness boundaries have been lower than the numbers on the districts lands outside the wilderness. The lightning caused fire season though has a similar monthly distribution minus the months of May and September. For the most part these differences can be attributed to a shorter, and normally more moist fire season occurring at the higher elevations within the wilderness.

There has never been any year-around weather stations kept within the boundaries of the Scapegoat Wilderness. It is necessary to use weather stations adjacent to the wilderness area to try and characterize the weather which may have occurred within those boundaries. Several stations were selected which effectively cover approximately 3/4's of the boundaries, leaving only the northern boundary adjacent to the Bob Marshall Wilderness. The Lincoln Ranger Station, Helena National Forest in Lincoln, MT has maintained weather records since 1948. This is the station which "drives" the decision making process for wilderness prescribed fires within the Blackfoot, Lincoln, and Halfmoon Units (USDA 1981). Particular emphasis has been paid to this station. Other stations selected include the Silver King Lookout, Seeley Lake Ranger Station, and Ovando for west of the Continental Divide; and Augusta, Choteau, Gibson Dam, and Gleason's Resort on the east side.

The stations in Lincoln, Ovando, Seeley Lake, Augusta, Choteau, and Gibson Dam are regular reporting stations for the National Weather Service (NWS). Weather readings taken at Silver King, Lincoln, Seeley Lake, and Gleason's Resort are also incorporated into the National Fire Danger Rating System (NFDRS). The NFDRS data is collected once daily at 1400 hours usually from May through October at designated AFFIRMS weather stations, though the months will vary from station to station. Measurements taken for inclusion into the National Fire Weather Data Library (NFWDL) (Fulman and Brink 1975) maintained by the USDA USFS Computer Center (FCCC) at Fort Collins, Colorado include; maximum and minimum daily temperature, relative humidity, dry and wet bulb temperature, wind speed, and 24 hour precipitation. Also several SNOWTEL sites are examined for snow water equivalent (SNOW) from the Lincoln and Rocky Mountain Ranger Districts. SNOW data is collected at some locations twice monthly (1st and 15th of the month) but only data from the 15th on each month is examined. Stream flow data (STRM) from the Sorth Fork of the Sun River and the Blackfoot River are examined to compare the 1988 stream gage measurements with the historical record. Reservoir storage (RESV) was also examined from the Nilan and Gibson Dam reservoirs comparing 1988 storage with the historical record. SNOW, STRM, RESV, and NWS data bases are maintained for the region by the USDA SCS West National Technical Center (WNTC) at Portland, Oregon by the Snow Water Program and Water Supply Forecasting Staff.

Section 3.1.0 West Side Climatology Characteristics and Comparisons with 1988

Section 3.1.1 LINCOLN RANGER STATION, HELENA NATIONAL FOREST

The Lincoln Ranger Station is about 9 miles to the south of the Scapegoat Wilderness and is only about 120 ft lower than the lowest elevation within the wilderness. The station lies within forested vegetation similar to that found within the Scapegoat Wilderness west of the Continental Divide. This station collects weather data for both the NWS and the NFDRS.

Section 3.3.1.1 **Precipitation**

Water Year (October-September) precipitation ranges from 12.48" (31.69 cm) which occurred in 1987 to 24.02 " (61.01 cm) in 1978. Average precipitation for the 36 year period (1953-1988) was 18.65" (47.37 cm)(Figure 14). During this time period there has been a slight declining trend in water year precipitation, which was heavily weighted by the dry 1986 through 1988 seasons. During the 25 years between 1961 and 1985 the trend was upward with an increase of +.23" (.58 cm). The 28 year period extending from 1965 through 1988 shows a declining trend of -.18" (.38 cm) illustrating the strong influence of the later dry years. After completion of the year in September, 1988 ranked as the 31st driest year out of the 36 years of records at Lincoln, with a return period estimated to be between 5 and 10 years.

Annual precipitation (January-December) at Lincoln during a 41 year period of records (1949-1989) had a range of 12.55" in (31.87 cm) in 1987 to 36.02" (91.49 cm) in 1975 (Figure 15). 1988 ranked as the 22nd driest annual record of the 41 years.

Pre-fire season precipitation, here defined as the October-June months to include the month when the Canyon Creek Fire originated and this period of precipitation data would have been available at the time the prescribed fire decision was made, had an average of 14.94" (37.94 cm) and extremes of 7.26" (18.44 cm) in 1973 and 22.59" (57.37 cm) in 1975 (Figure 16). The 1988 pre-fire season precipitation was ranked the 29th driest season with 12.80" (31.75 cm) out of a 36 year period of records (1953-1988). The 1988 pre-fire season precipitation has been calculated to have a return period of between 2 and 5 years. During the historic record there has been a trend of declining precipitation of approximately -2.6" (6.6 cm). During this period there has been no particular cycle of wet or dry pre-fire seasons, other than the relatively recent appearance of greater seasonal extremes from the average and longer periods of time in which this season is either above or below the average.

June-August precipitation is classified as fire season precipitation, again June is included because of the apparent effect of dry weather during this normally wet month in preconditioning fuel moistures. This season has received an average of 4.75" (12.06 cm) of precipitation with extremes of 1.63" (1961) to 9.99" in 1975 (Figure 17). The 1988 season ranked the 38th driest season out of 41 years of records (1948-1988) with 2.69" (6.83 cm), 59% of this total arrived during the month of June. The amount of fire season precipitation received in 1988 was calculated to have a return period of between 5 and 10 years. During the 41 year period this season has shown a declining trend of -0.9" (2.2 cm). The trend line may be influenced by greater than normal fire season precipitation during the early years of record keeping rather than any noticeable trend toward drier seasons.

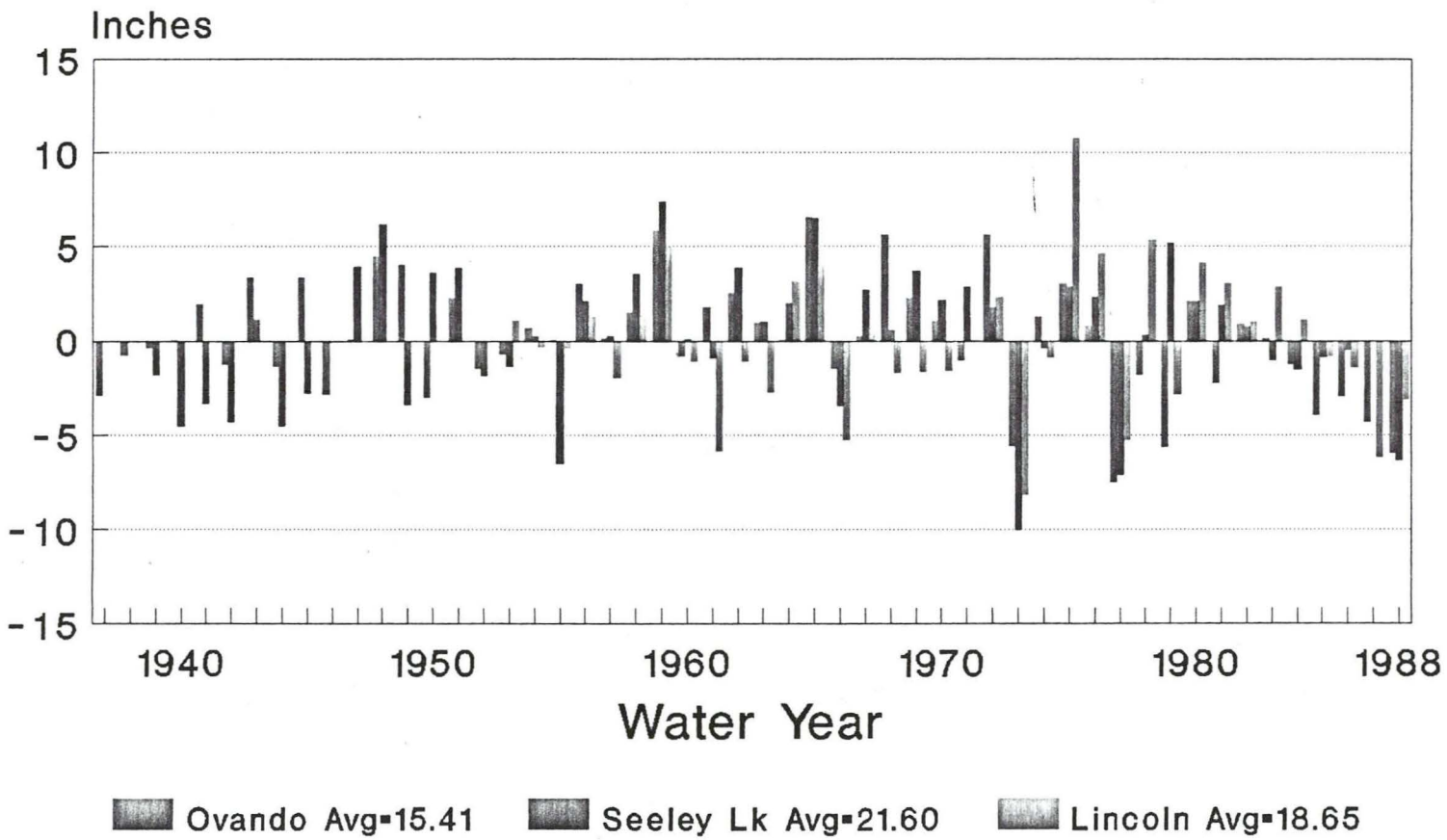
Precipitation for an extended fire season (June-September) at this station averages 6.01" (15.26 cm) with extremes occurring during the 1941 season (3.05", 7.74 cm) and 1975 which received 11.11" (28.21 cm). The extended fire season during 1988 ranked the 33rd driest season (4.36", 11.07 cm) out of 41 record keeping years with a return period calculated to be 5 years. During the 1988 season August received the least proportion of the precipitation (11%) while September received the greatest amount (38%).

At this station June has an average of 5 days during which it will receive 24 hour precipitation of 0.10" (.25 cm) or greater. The months of July through October each only average 3 days of receiving the same amount.

Figure 14. Water Year (October - September) difference from average precipitation totals for the Ovando station, Seeley Lake Ranger Station (Lolo National Forest), and the Lincoln Ranger Station (Helena National Forest).

Water Year Precipitation Total

Difference from Average

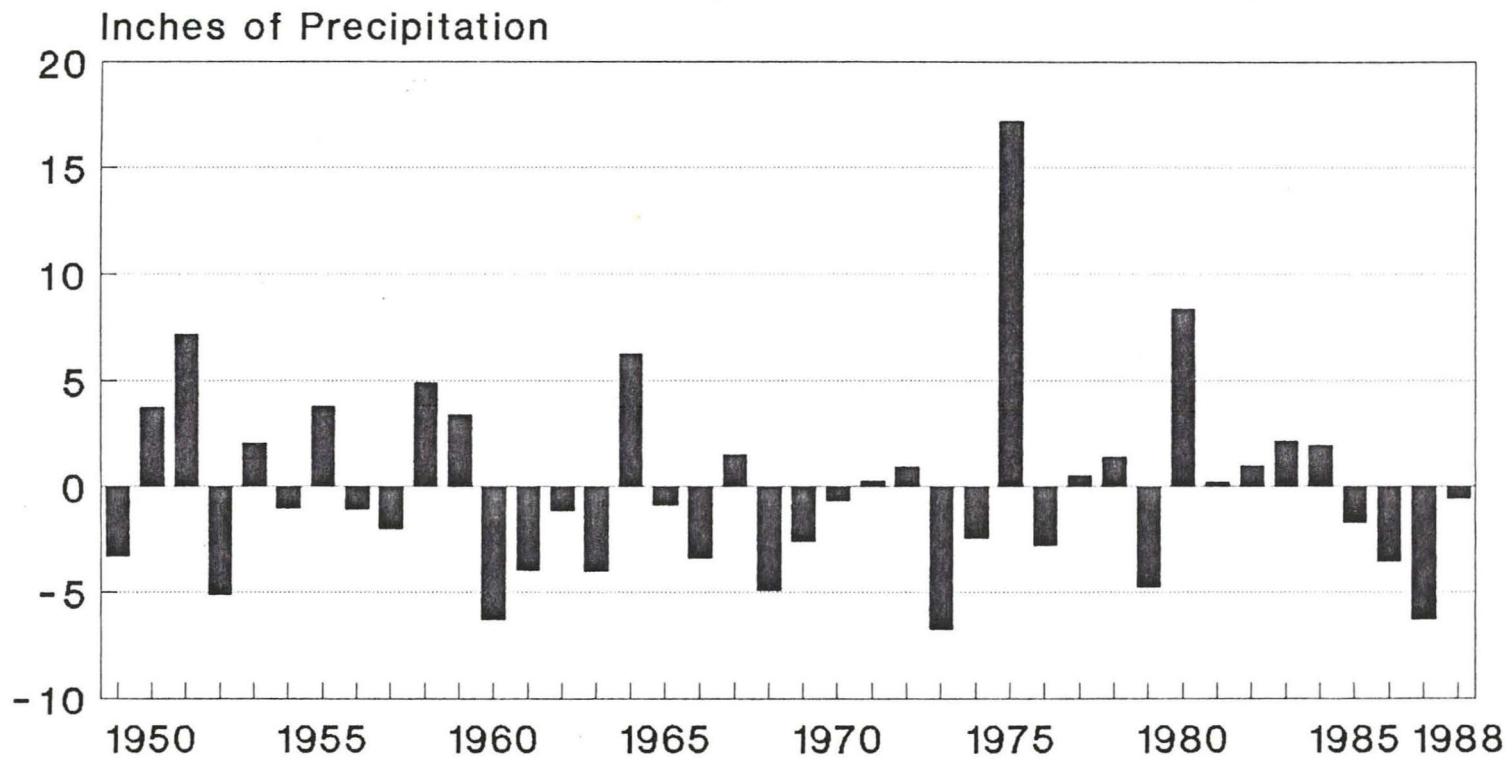


Stations west of the Continental Divide.

Figure 15. Difference from average of the annual precipitation at the Lincoln Ranger Station, Helena National Forest for the years 1949 - 1988.

Annual Preciptation In Inches

Lincoln Ranger District, Helena N. F.



Average PPT 1949 - 1988 = 18.82"

Figure 16. Pre-season (October - June) difference from average precipitation totals for the Lincoln Ranger Station, Helena National Forest.

October - June Precipitation

Difference from Average

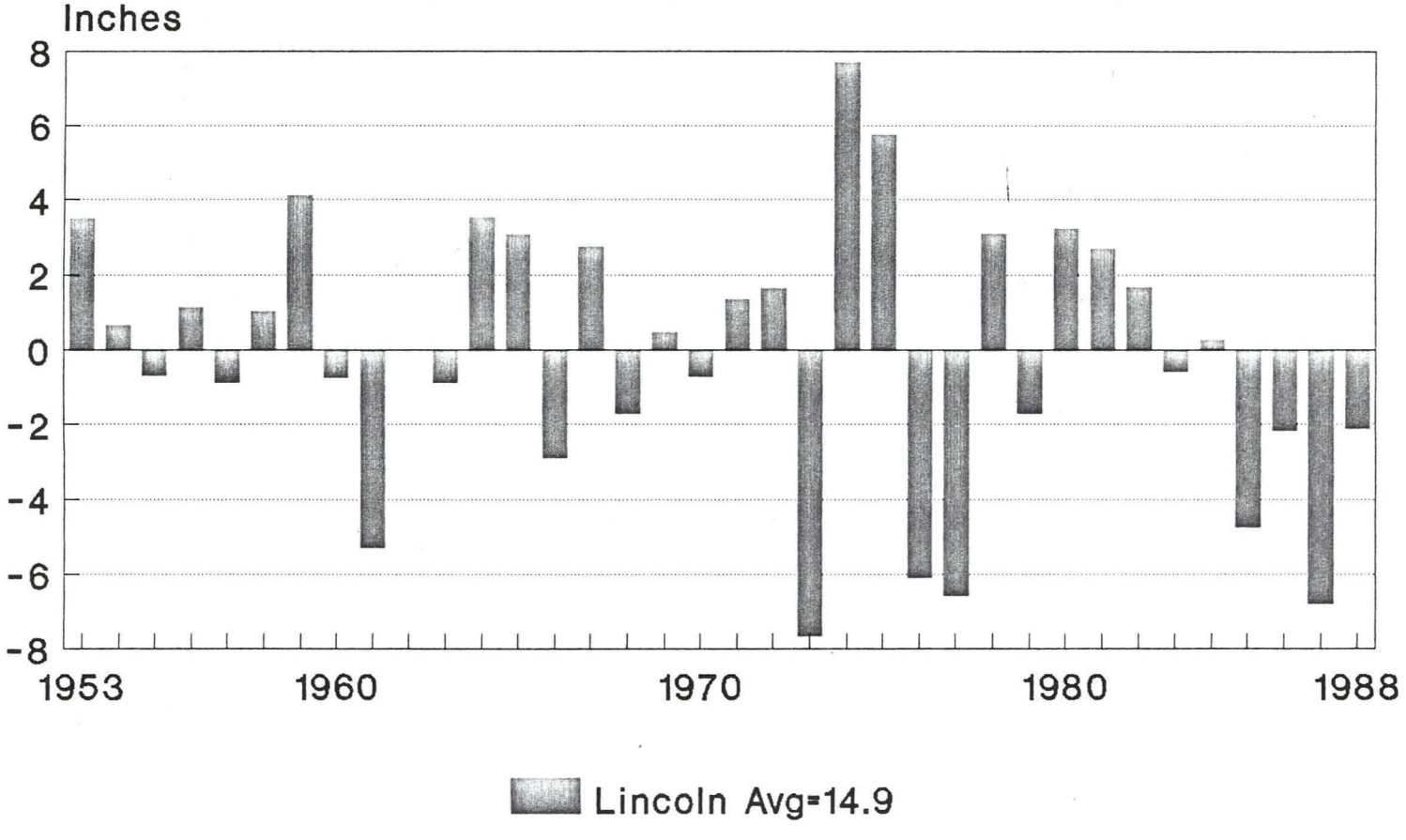
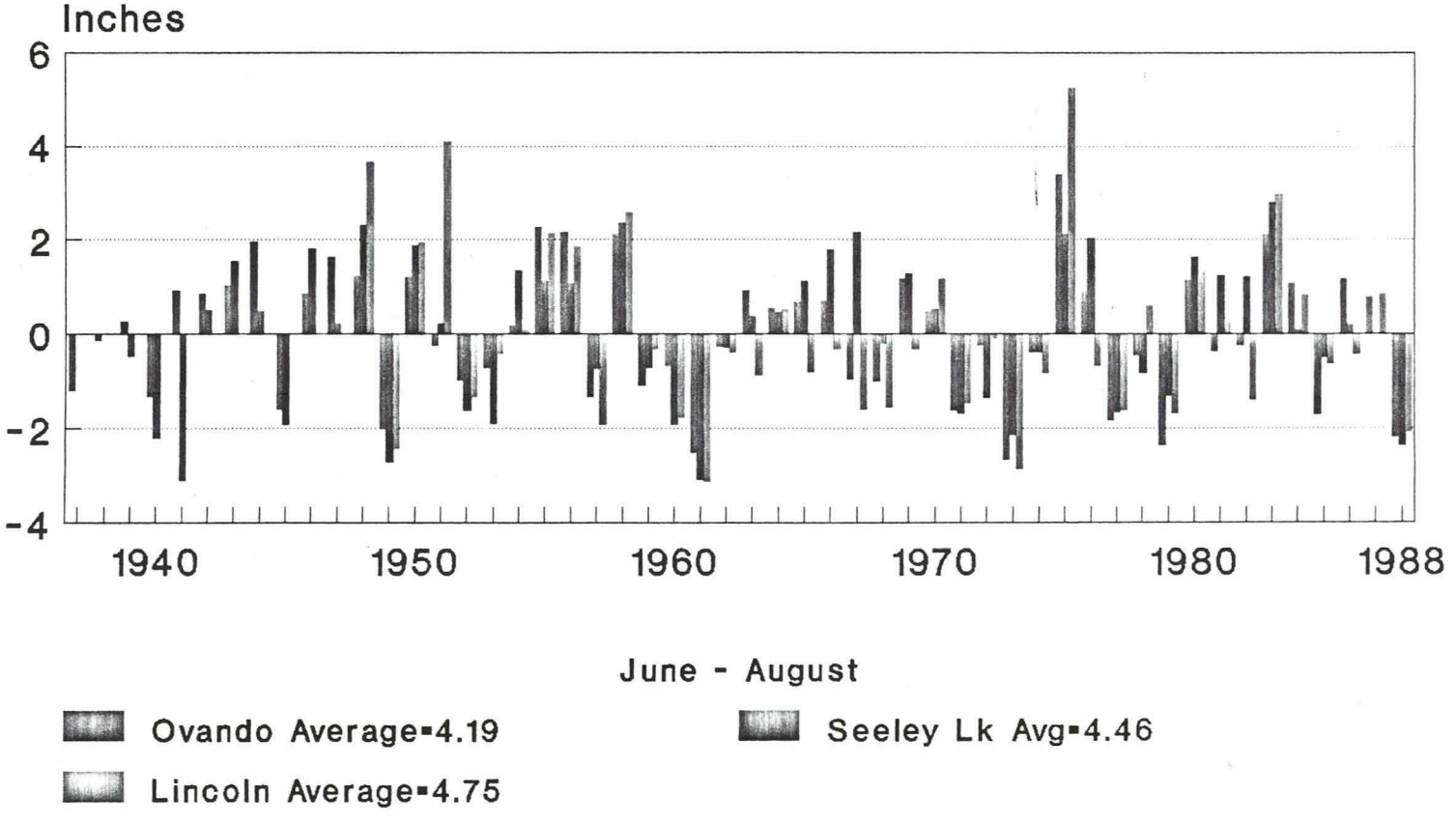


Figure 17. Fire season (June - August) difference from average precipitation totals for the Ovando station, Seeley Lake Ranger Station (Lolo National Forest), and the Lincoln Ranger Station (Helena National Forest).

Fire Season Precipitation

Difference from Average



Stations west of the Continental Divide.

Two snow measurement stations located on the Copper Creek drainage on the Lincoln Ranger District were the only stations near the wilderness on this district (Figure 18). They are located between 2 and 4 miles southeast from the wilderness boundary. The higher elevation site, Copper Camp (record for 1976-1988), had a snow water equivalent deficiet averaging about -5" (12.7 cm) from January through May (mid month measurements) 1988. No snow was measured in mid June when an average of 1.9" (4.82 cm) is normally present. The lower elevation station, Copper Bottom (record for 1976-1988) was nearly average from January through May. No snow was measured at this site in June which is normal. The station located at Lincoln measures snow depth only. The 1988 snow fall at Lincoln was below normal -18.7%. This followed the extreme 1987 season which was -51.8% below normal. Below normal snow fall at Lincoln had occurred since 1983, the longest period of below normal snow fall in the record (1949-1988) of this station (Figure 19). At Lincoln during 1988 no snow fell during April and May, this was the 5th time during the 40 years this had occurred.

Section 3.1.1.2 Temperature

The last killing spring frost (28F or lower) at the Lincoln station has a 50% probability of arriving later than June 6th, and a 10% probability of arriving later than June 22nd. The first killing frost of the fall has a 50% probability of arriving before August 28th, and a 10% probability of arriving before as early as August 13th.

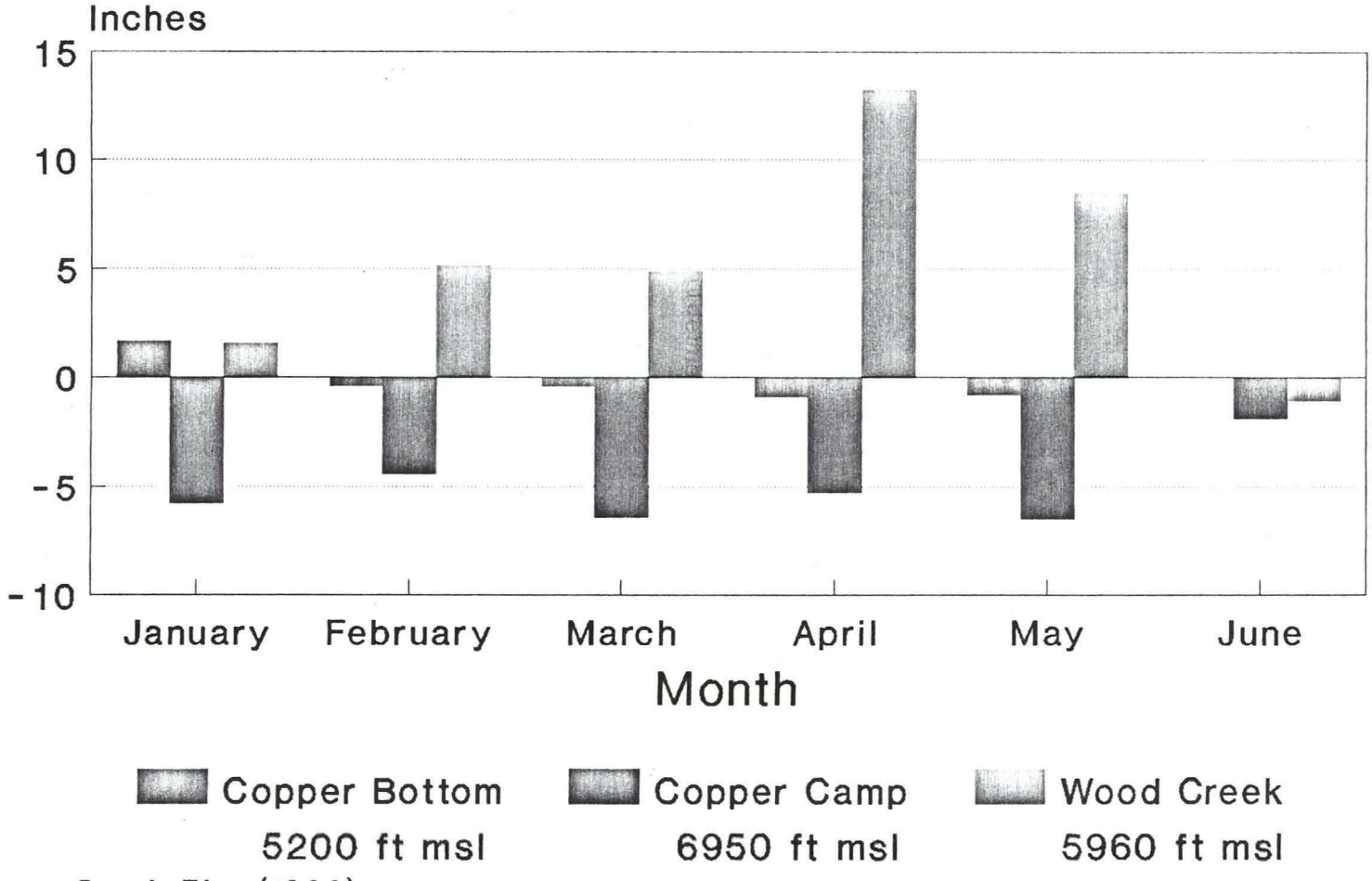
The average annual temperature is 40.1F (based on 1948-1988 records), with an average maximum temperature of 54.2F and a minimum average temperature of 25.9F. July experiences the warmest average daily maximum temperatures of 81F, followed by August with 80.5F. These two months also have the respective warmest average daily minimum temperatures of 61.2F and 60.1F. The extreme daily maximum temperature recorded was 102F. There is a 20% probability for either month that at some time a maximum daily temperature greater than 95F will be achieved.

The highest monthly mean maximum daily NFDRS temperatures also were recorded in July (80.4F), with the extreme average measurement occurring in 1985 at 88.4F. July is closely followed by August in this category which was 79.9F. June 1988 recorded the extreme daily NFDRS temperature for that particular month with a reading of 94F. 1988 also had the highest monthly mean maximum NFDRS temperature for October of 65.6F. The ten day period beginning July 21st has the highest mean maximum daily NFDRS temperature of 83.3F. Mean maximum daily NFDRS temperatures above 70F for ten day periods begin on June 11th and end during the September 1st period. During 1988 the highest historical mean maximum NFDRS temperatures during the ten day periods beginning June 21st (85.9F) and October 1st (74.7F) were recorded. Maximum daily NFDRS temperatures above 70F can occur at any time between May 1st and October 21st. For maximum daily NFDRS temperatures of 80F or greater the period is between May 1st and October 1st. Maximum daily NFDRS temperatures of 90F or greater occur between June 1st and September 11th, reaching the greatest frequency of occurrence during July 21st (32.2%). Maximum daily NFDRS temperatures 95F and greater also starts June 1st and ends during the September 1st period and peak during the August 1st period (2.3%). Temperatures of 100F or greater have infrequently been measured at this station during the months of July and August.

The highest monthly minimum NFDRS temperatures at this station for the months of June (44.1F) and October (31.3F) were measured during 1988. Also

Figure 18. 1988 difference from average snow water equivalent from stations near the Scapegoat wilderness.

Snow Water Equivalent
1988 Difference from Average

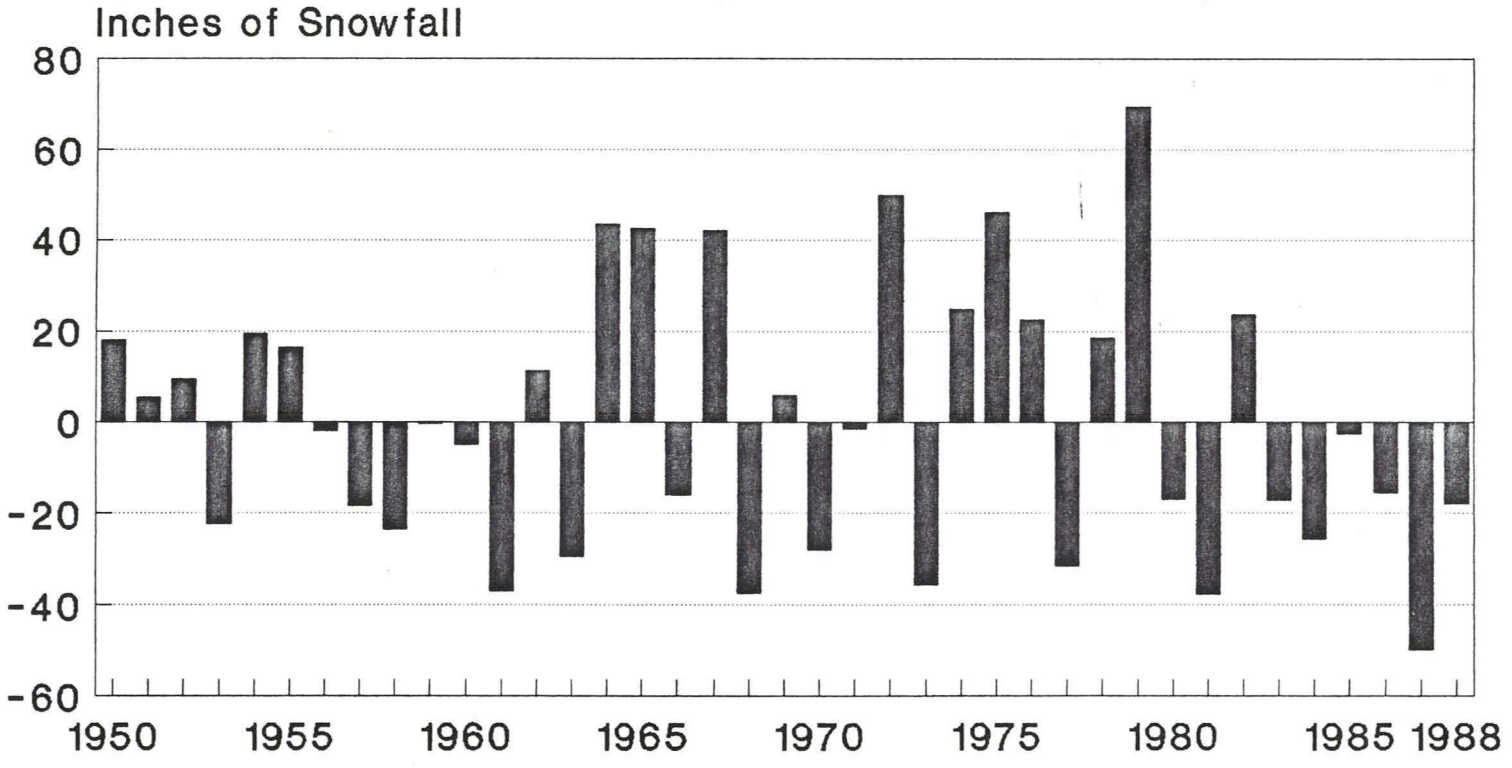


Canyon Creek Fire (1988)

Figure 19. Difference from average of the annual (September - May) snowfall the Lincoln Ranger Station, Helena National Forest for the 1949 - 1959 through 1987 - 1988 seasons.

Annual Snowfall (Sept to May)

Lincoln Ranger Station (241904)



Average Snowfall 1949/50 - 1987/88 = 96.57"

during 1988, October saw two ten day periods which experienced the record high minimum daily NFDRS temperature average of 33.8F (October 11th) and 34.7F (October 21st).

The monthly mean daily NFDRS temperatures follow very closely to the regular NWS monthly average daily temperatures readings, even thought the NFDRS measurements are only made once daily. July has the highest monthly mean daily NFDRS temperature of 61.0F (NWS 61.9F), followed by August with 59.9F (NWS 61.3). Records were set during 1988 for the highest monthly mean NFDRS temperatures for both June and October. Ten day period mean daily high NFDRS temperature extremes were set during the 1988 periods of June 1st (70F), June 21st (76F), and October 11th (54F).

Between 1967-1988 annual average high temperatures have declined slightly by about -0.4F, in spite of the fact that 1988 experienced the highest difference from average (+2.71F) during that time period. June-August average maximum temperatures during the same time period have increased by +0.5F. The 1988 June-August fire season had the highest difference from average of +6.6F of all seasons of record. The 1988 extended fire season experienced the same increase in average maximum temperatures as the regular fire season, and also recorded the warmest season with a difference from average of +6.2F (Figure 20).

The 1988 Water Year average monthly temperatures started off with a warm fall, a cool December (-1.8F), an average January, then a very warm late winter and spring with June peaking at +7.4F above average (Figure 21). The remainder of the Water Year had average monthly temperatures above average but to a considerable lesser degree than earlier in the year (+0.3F to +1.3F).

Section 3.1.1.3 Relative Humidity

The lowest maximum NFDRS RH class (10-14%) historically occurs during the ten day period beginning August 21st with a frequency of only 0.3%. The next major class encountered is 30-34% which occurs between August 11th and September 21st, with a peak frequency of 0.8% during that last ten day period.

The average low minimum NFDRS RH occurs during the August 1st and 21st ten day periods (16.5% frequency) and starts rising by September 1st. Of the total 18 ten day periods between May 1-October 21, there were 6 periods during 1988 when record low minimum NFDRS RH's were recorded. The month of August has the lowest average minimum NFDRS RH readings of 13.5%, followed by July with 13.7%. Minimum NFDRS RH measurements below 20% can occur anytime between May 1-October 21, with the ten day period of August 1 having the greatest frequency of occurrence (21.2%) in the 15-19% class. Measurements below 10% have two periods of occurrence; between July 1-September 1, then again between October 1-October 11, with the highest frequency of occurrence during the October 1st period (2.6%).

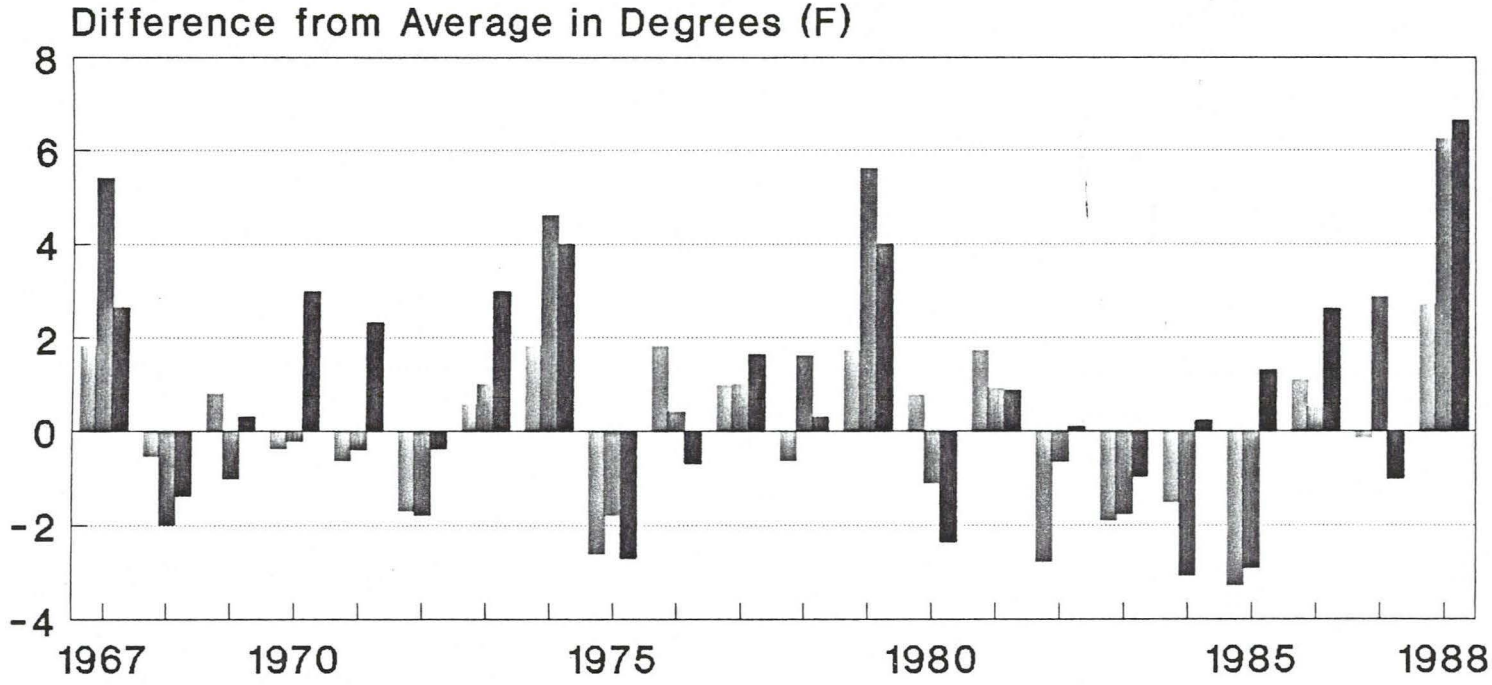
July experiences the lowest monthly mean NFDRS RH measurements (56.2%) followed by August (56.8%). August 1988 experienced the lowest historical monthly mean NFDRS RH measurement with 42.7%. The historical ten day period starting on July 21st has the lowest mean NFDRS RH (54.8%). Record lowest average NFDRS ten day period RH's occurred in 1988 during the following starting dates; July 21st, August 1st, August 24th, September 1st.

Section 3.1.1.4 Winds

NFDRS winds during the extended fire season average between 6.1 and 6.3 MPH with the greatest variability of range occurring during the month of June

Figure 20. Difference from average of the average high temperatures for the June - August, June - October, and annual time periods at the Lincoln Ranger Station, Helena National Forest for 1967 - 1988.

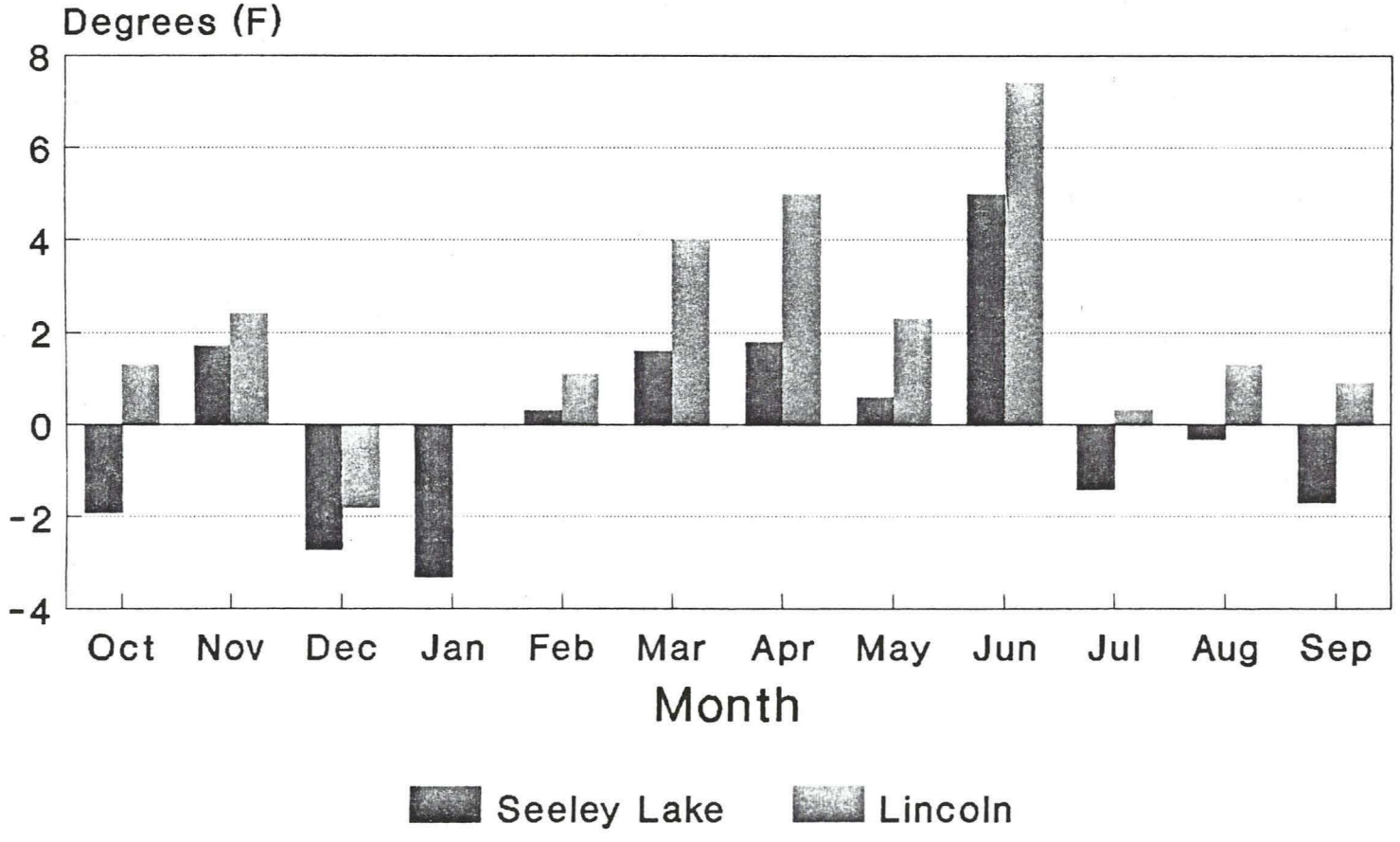
Average High Temperatures
Lincoln Ranger District, Helena N. F.



Annual Avg=53.6, June-Oct Avg=70.19, June-Aug=76.02

Figure 21. 1988 Water Year (October - September) difference from average of the average monthly temperatures at the Seeley Lake Ranger Station (Lolo National Forest), and the Lincoln Ranger Station (Helena National Forest).

Average Monthly Temperatures
1988 Water Year Differences from Average



(average range of 4.4 MPH from the northeast to 7.4 MPH from the northwest, does not include calm periods). During June NFDRS winds of 8-12 MPH occur with a frequency of 28.3%, 13-18 MPH 3.7%, 19-24 MPH 0.4%. July NFDRS winds occur between 8-12 MPH with a frequency of 26.9%, 13-18 MPH 2.6%, 19-24 MPH 0.1%, and greater than 24 MPH 0.2% of the readings. NFDRS winds for August indicate that 27.2% of the readings fall between 8-12 MPH, 13-18 MPH 3.4%, and 19-24 MPH 0.6%. September NFDRS wind measurements have 29.2% between 8-12 MPH, 13-18 MPH 3.3%, 19-24 MPH 0.1%, and greater than 24 MPH a frequency of 0.1%. Only the months of July and September had readings in excess of 24 MPH. October had the lowest NFDRS wind measurements with an average of 4.6 MPH. October winds between 8-13 MPH occurred 15.5% of the measurements, 13-19 MPH only 0.8%. No October measurements exceeded this last wind speed class.

Section 3.1.1.5 3-Way Co-occurrence of Extreme Burning Conditions and the Rxburn Program

A close examination of the weather conditions during periods of extreme burning conditions when fires in the Northern Rocky Mountains (principally NFFL Fuel Models 9 and 10) started to exhibit running crown fire behavior was made. These fires included prescribed fires within the Bob Marshall Wilderness complex, as well as wilderness wildfires and wildfires on the Flathead National Forest, Idaho Panhandle National Forest, and Glacier National Park. It was found that these fires commonly had temperatures 75F or greater, relative humidities of 25% or less, and minimum wind speeds of approximately 9 MPH when the fires started to exhibit crowning behavior. If temperatures climbed to 80F with the same relative humidities and minimum wind speeds crown fires were usually well developed. Crown fire behavior could be maintained with lower temperatures and rising humidities if during a frontal passage strong winds persisted or strengthened. To determine the number of days when these minimum conditions had been attained at AFFIRMS stations in the NFDRS, the "prescription" window was completed to include the potential extreme or hot side of the prescription. Temperatures of 95F, RH's of 1-10% (lowest classification) for the program 3-way and 5% for the Rxburn program, and 25 MPH for wind speed were used. None of the fires examined occurred during these extreme hot, dry prescription conditions. Most crown fires occurred between 75-80F, 15-25% RH and 9-20 MPH. It should be noted that these programs are for weather data analysis, as a result fuel moistures do not enter into the prescription. Prescription days may in reality be eliminated if fuel moistures are too high. Also the weather collected at 1400 hrs does not always represent the fact that the prescription may have been attained later in the day, in this respect the number of days of prescription attainment may be under estimated slightly. The analysis also does not take into account the fact that a fire may not be burning on a day within prescription, or that a fire which is burning has insufficient fuel or an effective barrier to prevent spread. Another limitation is the limited historical base for fire weather records, as well as the fact that there may be both individual days as well as even years missing from the data base of a particular station. And in case any of us forget, individual weather events do not follow any statistical description, these numbers only help us to try and understand the occurrences. There is no statistical reason why an event that we might rate as occurring once every 20 years based on the limited historical record, can not occur during consecutive years, or for that matter twice during a period of even shorter duration.

A close examination of the weather window of 75-95F, 1-30% RH, and 5-20> MPH for the months of June through September by the 3-Way program for the

Lincoln station show July and August with the highest frequency of occurrence. The period of data examined included 35 years from 1954-1988. June data showed that the above combination with wind speeds between 5-9 MPH occurred with a frequency of 10.9%, wind speeds within prescription starting with 10-14 MPH had a frequency of 3.3%, 15-19 MPH a frequency of 0.2%. June data with wind speeds of 20 MPH or greater were out of prescription and only occurred with an RH range of 21-40%, temperatures in the 65-74F range, and a frequency of occurrence of 0.2%. A crown fire already running could certainly continue burning under these or worse weather front passage (falling temperatures and rising humidities, sustained or stronger wind speeds) 1400 hour conditions for an undetermined length of time, but crown fire conditions become increasingly marginal and difficult to maintain and the slighest break in fuel or wind speed can end the run. July frequency of occurrence for data with wind speeds of 5-9 MPH was 27.4%, 10-14 MPH had 3.9%, 15-19 MPH conditions did not fall within prescription but with conditions expanded to include 65-79F and 21-40% RH the frequency was 0.4%. Again, July did not have data which fit the original weather window for wind speeds of 20 MPH or greater, but expanding the window to 50-79F with 21-70% RH had a 1.4% occurrence. The month of August had a frequency of occurrence with the original data window and 5-9 MPH wind speeds of 25.6%, 10-14 MPH was 5.6%, 15-19 MPH had 0.1%. Expanding the prescription for this last wind speed range to include temperatures of 60-79F and 21-60% RH caused an occurrence of 0.8%. Wind speeds of 20 MPH or greater within prescription had an August occurrence of 0.2%, and if the prescription was expanded to include temperatures of 65-79F and 21-60 RH the occurrence climbed to 0.5%. September frequency of occurrence for the various combinations declined in nearly all wind speed categories. Frequency of occurrence for September combinations of the original weather window with 5-9 MPH wind speeds was 10.6%, 10-14 MPH was 1.8%, and with wind speeds of 15-19 MPH was out of the prescription. Expanding this last wind speed class to include temperatures of 50-74F and 21-80% RH had an occurrence of 1.4%. Wind speeds of 20 MPH or greater and within the prescription had an occurrence of 0.1%, expanding this to include all observed data increased the ranges to 65-79F and 21-40% RH. This expanded window had an occurrence of 0.2%. AFFIRMS data for the Lincoln station covering the Canyon Creek Fire short-term catastrophic fire event on September 6, 1988 had readings of 83F, 18% RH, and 12 MPH wind speed (in prescription), and on September 7th after the fire run had ended the values were 67F, 21% RH, and 14 MPH wind speed. August had the highest percentage of occurrence of all weather prescription and wind speed combinations. Both August and September were the only months during which the weather prescription window combination occurred with wind speeds of 20 MPH or greater.

An examination of more restricted weather windows covering 4,864 days during 36 years was accomplished with the Rxburn program. The preferred prescription of 80-95F, 5-20%, and 9-25 MPH for weather during which crown fires were well developed had only a 1% occurrence, or a total of 65 days. August had the highest percentage of the 65 days with 46%; while in declining order occurred July with 31%, September 12%, June 6%, and May 5%. In terms of the entire fire weather record for this station this translates to 0.61%, 0.49%, 0.08%, and 0.06% for each of the respective months. No days in October met the requirements of the prescription. Another method of interpreting these results is an estimated return interval based on the number of years it would take for a single day in any particular month to be within prescription. This estimated return interval will be calculated using the actual data and not a return interval based on a statistical distribution, such as the return period of a particular Water Year. In chronological sequence it would take May 6.3

years to have 1 day in the preferred prescription, June would have 1 day each 7.1 years, July 1 day each 1.7 years, August would have 1 day each 1.2 years, and September would experience 1 day every 3.8 years.

An Rxburn program with an acceptable (parameters have a greater range) prescription illustrating the period of starting crown fire behavior of 75-95F, 5-25%, 9-25 MPH had a 2% occurrence (109 days) out of a total of 4,864 days of data. August again had the highest percentage of days within this window, 42%. This was followed by July at 28%, June with 22%, September at 13%, May with 3%, and October having 2%. In terms of the entire fire weather record for the Lincoln station the days meeting this prescription were 0.94%, 0.61%, 0.41%, 0.43%, 0.28%, 0.06%, and 0.04% for each of the respective months. Another way of presenting the same information in chronological order is that a return period of 6.3 years during the month of May is needed to attain 1 day meeting the acceptable prescription window, June and July both would have 1 day every 1.2 years, August will experience 1.3 days of being in prescription every year, September will have 1 day each 2.2 years, and October will need 6.3 years to attain a single day.

Section 3.1.2 SILVER KING LOOKOUT NFDRS STATION, HELENA NATIONAL FOREST

The fire lookout located on top of Silver King Mountain is a high elevation, 7,771 ft msl, short season NFDRS station. It is located approximately 2.5 miles from the southeast corner of the Scapegoat Wilderness boundary, and is only 4 miles from the nearest part of the Continental Divide. This is the only station described which is both near the wilderness and above the lowest elevation point in the wilderness, by about +3,050 ft, and is the only station that can be used to characterize high elevation weather conditions within the Scapegoat Wilderness. The data collected at this station is also very limited in the number of years of record.

Section 3.1.2.1 Precipitation

Records for precipitation at the Silver King Lookout have been maintained since 1954, and the number of years individual ten day periods may have data varies from 11 to 35 years. The period between July 1st and September 10th are the most complete with the 35 year record.

July receives an average monthly precipitation of 0.84" (2.13 cm). The mean precipitation for August declines to 0.71" (1.80 cm). The first ten day period of July has 0.47" (1.19 cm) mean precipitation and moisture received declines from that period to a low during the period beginning August 1st. Between August 11th and August 31st an increase in mean moisture received is observed. Mean precipitation during the first ten day period of September is the lowest for the entire season at 0.17" (0.43 cm). The frequency of occurrence of daily precipitation amounts of greater than 0.20" (0.50 cm) declines rapaidly after July 10th to the lowest occurrence during the ten day period beginnng August 1st. The next ten day period historically receives more days with precipitation greater than 0.20" (0.50 cm) than any other during the summer season.

Section 3.1.2.2 Temperature

Temperature data at this station has been collected for a maximum of 10 years (1968, 1971-1973, 1983-1988) for a 30 day period begining July 21st and ending August 20th. A minimum of 5 years of data (individual ten day periods

very in the year in which the data was collected) has been collected for the period starting June 21st through September 10th. It will be within this 5 years of data that some climatological attributes of the station will be derived. Limited data has been collected outside the June 21-September 10 period and will only be used in deriving monthly mean values.

NFDRS maximum monthly mean daily temperature during July is 67.4F, drops slightly in August to 66.3F, and the value for September is only 56.4F. The ten day period with the NFDRS maximum mean daily temperature occurs beginning June 21st and a value of 69.6F. A slight cooling trend then follows for the next 20 days. A return to NFDRS maximum mean temperatures of between 68.9F and 62.9F have been recorded for the period between July 21st and August 31st. NFDRS ten day maximum mean temperatures drop in to the 50's during September. The maximum daily temperature attained at this station has been 92F during the July 11, 1984 ten day period.

August is the month with the highest NFDRS minimum daily temperature of 44.2F, followed by July with 43.8F. The ten day period beginning June 21st has the NFDRS minimum mean daily temperature of 45.1F and is followed by a 20 day period of cooler mean minimum daily temperatures. The 20 day period beginning July 21st has the stations maximum mean minimum daily temperature of 45.9F after which the values decline.

Silver King Lookout has an August NFDRS monthly mean daily temperature of 44.2F while July is slightly cooler at 43.8F. The period of maximum NFDRS mean daily temperatures occurs between July 21st and August 10th.

Numerous records were established for temperatures during the 1988 season at this station. But because of the limited data base they lack much meaning.

Section 3.1.2.3 **Relative Humidity**

Measurement of relative humidity at the Silver King Lookout, except for 1 period in 1973, has been restricted to the years 1983-1988. During these years the best period of record is between July 1st and September 1st and will be the period emphasized.

NFDRS maximum daily relative humidities below 30% may occur at anytime between July 21st and September 1st, with the first ten day period having the highest frequency of occurrence (6.8%). The lowest NFDRS monthly mean minimum RH occurs during August (33.8%) though July is not much different. July 21st is the ten day period with the lowest mean minimum relative humidity of 32.8% during the time period of most complete weather records. Minimum daily relative humidities below 30% may occur at almost anytime this lookout is manned during the summer months. Values below 10% have only been measured between August 11th and August 31st.

Section 3.1.2.4 **Winds**

Wind data has been collected at the Silver King Lookout for 1-19 years depending on the ten day period examined. This section will only include the ten day periods from July 1-September 10 for which there is at least a minimum of 12 years of data. Because of the higher elevation of this station these wind measurements are essentiallly recordings of free air movement uninhibited by the topography and thick vegetation of the lower stations. As a result wind speeds are much higher than the lower elevation sites. This is the only station which has wind speeds in excess of 24 MPH during all time periods examined. Average wind speeds gradually increase as the season progresses.

NFDRS winds during the month of July average 15.1 MPH with a range of 8.1 MPH from the east to 17.4 MPH from the west (does not include calm periods). During July NFDRS winds of 8-12 MPH occur with a frequency of 27.5%, 13-18 MPH 27.5%, 19-24 MPH 15.0%, and winds greater than 24 MPH have a frequency of 13.5%. An average wind speed of 15.6 MPH (not including calm periods) has been measured in August with ranges of 7.6 MPH from the southeast to 18.5 MPH out of the west. August NFDRS winds occur between 8-12 MPH with a frequency of 29.7%, 13-18 MPH 25.8%, 19-24 MPH 14.1%, and greater than 24 MPH 15.6% of the readings. NFDRS winds for the first ten day period in September indicate that an average wind speed of 16.9 MPH occurs with a range of 6.5 MPH from the east to 18.5 MPH out of the west and northwest. 32.5% of the readings fall between 8-12 MPH, 13-18 MPH 23.8%, 19-24 MPH 20.0%, and 16.3% of the measurements taken are greater than 24 MPH.

Section 3.1.2.5 3-Way Co-occurrence of Extreme Burning Conditions and the Rxburn Program

An examination of the prescription window used with the 3-Way program analysis of the Silver King Lookout stations AFFIRMS data of 75-95F, 1-30% RH, and 5-20> MPH for the months of July through the first ten day period of September show July and August with the highest frequency of occurrence. The period of data examined included 12 through 19 years of data depending on the ten day period in question for the years 1961-1973 na 1983-1988. July frequency of occurrence for data with wind speeds of 5-9 MPH was 0.8%, 10-14 MPH had 0.6%, 15-19 MPH was 0.4%, and wind speeds of greater than 20 MPH had a frequency of occurrence of 0.2% within the prescription. Expanding the window to cover wind speeds of 20 MPH or greater, temperatures down to 50F, and RH values up to 70% increased the frequency of occurrence to 19.6%. The month of August had a frequency of occurrence with the original data window and 5-9 MPH wind speeds of 2.2%, 10-14 MPH was 2.8%, 15-19 MPH had 1.6%, 20 MPH or greater was 1.6%. Expanding the prescription to the include the same ranges for the variables in July increased the frequency of occurrence to 17.0%. Frequency of occurrence for the first ten day period of September various declined in all prescription categories. Frequency of occurrence for September combinations of the original weather window did not occur with either the 5-9 MPH, or 10-14 MPH categories. Wind speeds of 15-19 MPH dropped to 1.3%. Wind speeds of 20 MPH or greater also declined to 1.3% occurrence. Expanding the window as above increased the occurrence to 21.9%. AFFIRMS data for this station covering the Canyon Creek Fire short-term catastrophic fire event on September 6, 1988 had readings of 64F, 28% RH, and 16 MPH wind speed. Temperature was -11F below prescription, RH was slightly out of prescription by +3% at this higher elevation station. Shortly after this reading temperatures climbed to about 67F and relative humidity continued to drop to 18%, and wind speeds increased to 26 MPH. At this point in time (1600 hours) the station was only -8F out of prescription and the fire was running at the lower elevations. The station was abandoned for safety reasons the morning of the 7th because the Canyon Creek Fire had raced through the timber only a few miles to the north. No AFFIRMS readings were taken on the September 7th.

An examination of more restricted weather windows covering 1,233 days over 20 years between 1951 and 1988 was accomplished with the Rxburn program. The preferred prescription of 80-95F, 5-20%, and 9-25 MPH had only a 0.2% occurrence, or a total of 3 days. August had all of the occurrences for a frequency of 0.5% out of 522 days of record. This data could also be

interpreted as meaning that for the month of August there will be 1 day that may meet the preferred prescription each 5.6 years.

An Rxburn program acceptable (parameters have a greater range) prescription of 75-95F, 5-25%, 9-25 MPH had a 2.1% occurrence (26 days) out of a total of 1,233 days of data. August again had the highest percentage of days within this window, 3.8%. This was followed by May with 3.2%, September with 1.3%, and July with 0.6%. May and September had high percentages mainly because of a much reduced period of record. Again, in terms of the entire fire weather record for the Silver King station the days meeting the acceptable prescription were 1.6% for August, July was 0.2%, September 0.1%, and May 0.08%. Another way that this could be interpreted is for each month in chronological sequence there is 1 day each year for May when the acceptable prescription window is met (misleading because of limited data), June has never had a day in prescription, July 1 day each 5.2 years, August has the possibility of having 1 day each year, and September 1 day each 2.4 years.

Section 3.1.3 OVANDO, MONTANA

This NWS recording station is approximately 14 miles to the southwest of the Scapegoat Wilderness and about 465 ft lower in elevation than the lowest point within the wilderness. This grassland, valley site does not well represent conditions in the higher elevation, timbered wilderness even though it may be closer in terms of mileage than other west side NWS stations. Also the period of temperature record keeping at his station is very short, starting in 1976, allowing for only limited comparison with the 1988 season. Ovando is presented to help complete our understanding of weather conditions during the 1988 fire season. Pre-fire season precipitation was not segregated out for examination at this station since it would have little relation to actual conditions within the wilderness. However; Water Year, fire season, and extended fire season values for precipitation are presented. A brief review of temperatures at this station are also presented. This is also not a NFDRS station and information such as fire season winds and relative humidity are not available.

Section 3.1.3.1 **Precipitation**

Water Year precipitation averages 15.41" (39.14 cm) for the 52 year period between 1937-1988. Ranges have extended from 7.92" (20.11 cm) in 1977 to 21.98" (55.82 cm) in 1965. There has been a declining trend of -1.82" (4.62 cm) during the historical record period for the 52 years. During the 25 year period between 1961 and 1985 there was a slight increase over average of +.05" (.12 cm). The 1986-1988 Water Years at this station have all been below average and have reversed the 25 year increase into a negative trend over 28 years with a decline of -.43" (1.09 cm). 1988 was the driest year during this later period with 9.47" (24.05 cm) and ranked the 51st driest year out of the 52 year record. A return period of between 20 and 100 years was calculated for the amount of precipitation which fell during the 1988 season. This station appears to fluctuate less than other west side stations in precipitation totals, however, since 1977 it has been experiencing a stronger trend toward drought than the other stations have. No apparent precipitation cycles were noted from the record. The 1973 season stands out as an exceptionally dry year during a 21 year period of mostly wet weather from 1956-1976.

Fire season precipitation totals range from 1.53" (3.88 cm) in 1973 to 7.59" (19.27 cm) in 1975, and averaged 4.19" (10.64 cm) over a 52 year period. The

1988 fire season at this station was ranked the 49th driest season out of the 52 years with 2.01" (5.10 cm), with 51% of that total arriving in June. The return period for the 1988 season total is between 10 and 20 years. A slight declining trend in precipitation of -0.4" (1.0 cm) has occurred during the record keeping period.

The June-September extended fire season at Ovando averages 5.46" (13.86 cm) with ranges from 2.01" (5.10 cm) in 1979 to 8.76" (22.25 cm) during 1975. This season during 1988 was ranked the 51st driest during a 52 year record with a total of 2.91" (7.39 cm). June of 1988 received the greatest amount of the precipitation during the season (35%), while August received the least (8%).

The month of June at Ovando will average 4 days during which it will receive precipitation of 0.10" (.25 cm) or greater within a 24 hour period. July only averages 3 days during which it may receive that amount of moisture. August and September average 4 days similar to June.

Section 3.1.3.2 **Temperature**

The last killing frost of spring in Ovando has a 50% probability of arriving later than June 7th, and a 10% probability of occurring later than June 24th. The first killing frost in the late summer has a 10% probability of arriving before August 24th, and a 50% probability of before September 4th. This station has an average annual temperature of 38.3F (based on a 1976-1988 record), with a maximum annual temperature of 53.3F and a minimum annual temperature of 23.3F. August has the warmest average daily maximum temperature of 78.8F, followed closely by July with 78.1F and then June. The extreme maximum daily temperature was 97F. A very slight reversal in the monthly sequence occurs when examining the average monthly temperature with July at 59.7F being slightly higher than August at 59.2F due to August having cooler average daily minimum temperatures. During July and August there is a 20% probability that a daily maximum temperature of 95F or greater will be achieved sometime in the time period.

Comparing the NWS average monthly temperatures for 1988 with the averages for the 13 year period 1976-1988 finds that Ovando had a slightly warmer than normal late winter and early spring ranging from +0.9F in March to +2.4F during April. June had the greatest departure from average with a warm +4.4F, then temperatures dropped back closer to normal with only a +1.9F difference in July and +0.6F difference during both August and September. By the end of the 1988 Calender Year Ovando had experienced an annual difference from average of +2.2F.

Section 3.1.4 SEELEY LAKE RANGER STATION, LOLO NATIONAL FOREST

The Seeley Lake Ranger Station is approximately 20 miles to the west of the Scapegoat Wilderness and is about 700 ft lower in elevation than the lowest area in the wilderness. This station normally receives a greater amount of precipitation, especially during the winter than do other recording stations surrounding the wilderness and in part due to this high precipitation zone lies within a highly productive timber area. Much of this greater precipitation is due to orographic lifting at the southern end of the Swan Mountain Range. This station operates as both a NWS and NFDRS data collection location.

Section 3.1.4.1 **Precipitation**

The Water Year precipitation at Seeley Lake averages 17.84" (45.31 cm) with extremes of 9.88" (24.33 cm) during 1973 and 24.47" (62.15 cm) in 1959. During the 48 year period of record gathering (1939-1988) at this station there has been a slight increasing trend in precipitation of +0.4" (1.0 cm). This station has had most years of precipitation either near average or above, only during the late 1930's through 1945 and again from 1983-1988 have extended periods of drought occurred. During the 25 year period between 1961-1985 above average precipitation was noted of +.37" (.93 cm). Extending the period through 1988 (27 years, incomplete data was recorded for 1987 and is not included but would most likely have also resulted in a below average year) the increasing trend noted for 1961-1985 was lessened to only +.07" (.17 cm) showing the continuing strong influence of dry weather. The 1988 Water Year was ranked the 44th driest out of the 48 year period of records with 15.30" (83.05 cm) of moisture received. A calculated return period for a season as dry as the 1988 Water Year was estimated between 20 and 100 years.

Precipitation during the fire season has averaged 4.46" (11.32 cm) over a 49 year period with extreme seasons recording 1.38" (3.50 cm) in 1961 and 7.57" (19.22 cm) in 1941. Precipitation during this season in 1988 ranked as the 47th driest year on record out of 49 years of records with 2.11" (5.35 cm) of which 64% arrived during June. The 1988 fire season precipitation was calculated to have a return period of between 10 and 20 years. A slight rising trend in precipitation for this historic record is noted for this station, with an increase of about +.5" (1.2 cm). Dry seasons at this station were usually single or double year events until the 1950's when dry seasons started to become more common. However, periods of above average precipitation since the 1950's have also tended to last for a longer series of seasons.

Extended fire season months have an average of 5.96" (15.13 cm) of precipitation for the period with extreme seasons of 2.92" (1.14 cm) in 1988 and 9.80" (14.89 cm) in 1985 over 49 years of records. The 1985 high extreme received over 59% of the precipitation in September after very dry months of June and July. During 1988, June received 46% of the moisture for this period.

The month of June has on the average 5 days during which the station will receive 0.10" (.25 cm) or greater 24 hour precipitation. During July and August the average number of days for this total of daily moisture drops to 3, then rises to 4 in September.

Section 3.1.4.2 **Temperature**

The last spring killing frost has a probability of arriving in Seeley Lake 50% of the time later than May 23rd, and 10% of the time later than June 11th. The first killing frost of the winter season has a 10% probability of arriving earlier than August 25th, and 50% probability of being earlier than September 13th. This station has an average annual temperature of 41.0F (based on a record from 1948-1988) and an annual maximum temperature of 55.0F. The month of July has the greatest average daily temperature of 62.0F, and the highest average daily maximum temperature of 81.4F. August follows July as a close second in both values. The extreme average daily maximum temperature is 101F. July and August both have a 20% probability of having at least one daily maximum temperature of 95F or greater. June and September have an similar probability of having at some time a daily maximum temperature of 90F or greater.

The highest monthly mean maximum NFDRS temperatures at Seeley Lake occur during the months of July (81.3F) and August (80.8F) with the extreme monthly average high of 89.5 occurring July 1985. The ten day period mean maximum NFDRS temperature high occurred during the period beginning July 21st, 84.1F. During 1988 there were record ten day period mean maximum NFDRS temperatures set, or tied during the periods beginning May 21st, June 21st, and October 1st. Record extreme maximum NFDRS temperatures were set during the 1988 ten day periods beginning May 11th, June 21st, and October 11th. Maximum daily NFDRS temperatures of 70F or greater can be expected to occur from May 1-October 11, with a peak frequency during the October 1st period (26.7%). Temperatures of 80F and above occur between May 1-October 1, with the greatest frequency of occurrence at July 21st (30.1%). Maximum daily NFDRS temperatures of 90F or greater occur between June 1-September 11, with peak occurrence during the August 1st period (18.3%). Temperatures of 95F or above have a bimodal distribution, occurring during the ten day period beginning June 1st (2.1%) and again between July 1-August 21. A peak frequency of occurrence during this latter period occurs during the July 21st period (2.9%). Temperatures of 100F or greater have been recorded during both months of July (0.1%) and August (0.2%).

The highest monthly mean daily temperature occurs during July (42.7F), followed by June and August (41.3F). During 1988 the ten day periods starting on June 21st and October 11th either tied or had record highest mean daily NFDRS temperatures. Both of those periods and the one beginning on May 21st experienced record extreme mean daily values.

The 1988 Water Year started off with a cool (-1.9F) October at Seeley Lake, a warm November (+1.7F), cold December-January months (-2.7F, -3.3F; respectively). Beginning in February above average monthly average temperatures arrived, peaking in June with a difference from average of +5.0F. The remainder of the Water Year saw temperatures below the monthly average. The 1988 Calender Year ended being +0.3F warmer than the annual average temperature.

Section 3.1.4.3 **Relative Humidity**

Low maximum NFDRS RH measurements (20-24%) occur during the months of July (0.1% frequency) and September (0.1% frequency). Low maximum NFDRS RH values between 20-54% may occur at any time during July through September.

The ten day period with the lowest average minimum NFDRS RH begins on August 11th (15.3%) and follows two other ten day periods with nearly as low values. Monthly average low NFDRS RH reach a summer minimum of 13.9% in August, begins to climb in September then falls to the monthly low value of 13.0% in October. During 1988 there were ten day periods which had record low daily NFDRS RH values; May 11, June 1, and October 1. The last two ten day periods also established record monthly extreme low values of 10% and 12% respectively. Minimum NFDRS RH values of less than 20% may occur at anytime between May 1-October 21 ten day periods, with the peak period being October 21st with a 36.4% frequency of occurrence. Minimum NFDRS RH values below 10% occur between July 1-September 1, and the ten day period beginning August 1 has the greatest frequency of occurrence of 1.2%. Minimum NFDRS RH values between 0-4% have been recorded during the ten day periods beginning July 1st (0.6% frequency) and September 1st (0.3% frequency).

October has the lowest monthly mean NFDRS RH value of 60.5%. October is closely followed by July (62.0%) and August (62.2%). September is a period of slightly more moist atmosphere with an monthly mean NFDRS RH value of 64.3%.

Section 3.1.4.4 **Winds**

NFDRS winds during the extended fire season average between 3.0 and 5.3 MPH with the greatest variability of range occurring during the month of August (average 2.6 MPH from the northeast - 5.3 MPH from the northwest, does not include calm periods). During June NFDRS winds of 8-12 MPH occur with a frequency of 11.1%, 13-18 MPH 2.3%, 19-24 MPH 0.2%. July NFDRS winds occur between 8-12 MPH with a frequency of 10.9%, 13-18 MPH 0.9%, 19-24 MPH 0.3%, and greater than 24 MPH 0.1% of the readings. NFDRS winds for August indicate that 11.9% of the readings fall between 8-12 MPH, 13-18 MPH 1.8%, and 19-24 MPH 0.3%. September NFDRS wind measurements have 12.9% between 8-12 MPH, 13-18 MPH 1.6%, 19-24 MPH 0.1%, and greater than 24 MPH a frequency of 0.1%. Only the months of July and September had readings in excess of 24 MPH. October had the lowest NFDRS wind measurements with an average of 3.0 MPH. October winds between 8-13 MPH occurred 7.8% of the time with no greater wind speed classes having any measurements.

Section 3.1.4.5 **3-Way Co-occurrence of Extreme Burning Conditions and the Rxburn Program**

An examination of the prescription window used with the 3-Way program analysis of this stations AFFIRMS data of 75-95F, 1-30% RH, and 5-20> MPH for the months of June through September show July and August with the highest frequency of occurrence. The period of data examined included 35 years from 1954-1988. June data showed that the above combination with wind speeds between 5-9 MPH occurred with a frequency of 5.4%, 10-14 MPH had a frequency of 2.0%, 15-19 MPH a frequency of 0.6%. June data with wind speeds of 20 MPH or greater had only occurred with a RH range of 31-40%, temperatures in the 70-74F range, and a frequency of occurrence of 0.2%. July frequency of occurrence for data with wind speeds of 5-9 MPH was 17.5%, 10-14 MPH had 2.0%, 15-19 MPH was 0.2%. Again, July did not have data which fit the original weather window for wind speeds of 20 MPH or greater. July extreme winds occurred with a RH range of 31-50%, and a temperature range of 50-74F, and had a frequency of occurrence of 0.3%. The month of August had a frequency of occurrence with the original data window and 5-9 MPH wind speeds of 19.4%, 10-14 MPH was 2.2%, 15-19 MPH had 0.7%, 20 MPH or greater was 0.3%. September frequency of occurrence for the various combinations declined in all categories. Frequency of occurrence for September combinations of the original weather window with 5-9 MPH wind speeds was 7.6%, 10-14 MPH was 1.7%, and with wind speeds of 15-19 MPH dropped to 0.1%. Wind speeds of 20 MPH or greater did not fit within the September window until the range was expanded to include ranges of 31-50% RH and 50-74F. This expanded window had an occurrence of 0.2%. AFFIRMS data for this station covering the Canyon Creek Fire short-term catastrophic fire event on September 6, 1988 had readings of 77F, 27% RH, and 18 MPH wind speed (RH was slightly out of prescription by +2%), and on September 7th the values were 66F, 33% RH, and 20 MPH wind speed. August had the highest percentage of occurrence of all weather prescription and wind speed combinations. August was also the only month during which the weather prescription combination occurred with wind speeds of 20 MPH or greater.

An examination of more restricted weather windows covering 3,625 days during 36 years was accomplished with the Rxburn program. The preferred prescription of 80-95F, 5-20%, and 9-25 MPH had only a 1% occurrence, or a total of 40 days. August had the highest percentage of the 40 days with 60%; while in declining order occurred July with 30%, June 8%, and May 3%. In terms

of the entire fire weather record for this station the data translates to frequencies of 0.66%, 0.33%, 0.08%, 0.02% for each of the respective months. This data could also be interpreted as meaning that for each month in chronological order there will be 1 day that meets the preferred prescription each 3.3 years for the month of May, June will have 1 day each 5.6 years, there will be 1 day each 2.9 years during July, and August will experience 1 day each 1.5 years.

An Rxburn program acceptable (parameters have a greater range) prescription of 75-95F, 5-25%, 9-25 MPH also had a 1% occurrence (39 days) out of a total of 3,546 days of data. August again had the highest percentage of days within this window, 38%. This was followed by July with 23%, June with 21%, September with 15%, and May having 3%. Again, in terms of the entire fire weather record for the Seeley Lake station the days meeting the acceptable prescription were 0.41%, 0.24%, 0.22%, 0.16%, 0.02% for each respective month. Another way that this could be interpreted is for each month in chronological sequence there is 1 day each 3.3 years for May when the acceptable prescription window is met, June has 1 day each 2.0 years, July 1 day each 4 years, August 1 day each 2.4 years, and September 1 day each 4.5 years.

Section 3.1.4.6 **Stream Flow of the Blackfoot River Near Bonner**

Stream flow of the Blackfoot River at the gaging station near Bonner results from precipitation received principally within both the Clearwater and Blackfoot drainages. Both drainages are influenced by moisture which falls in or near the Scapegoat Wilderness. Stream flow at this site during the 1988 Water Year was consistently well below normal (52-55 years of record depending upon the month)(Figure 22). Peak flow months of April, May, and June were well below normal. For the period January through September 1988 was ranked as the 49th lowest total flow over 52 years, with a calculated return period of between 20 and 100 years.

Section 3.2.0 <u>East Side Climatology Characteristics and Comparisons with 1988</u>

Section 3.2.1 AUGUSTA, MONTANA

The community of Augusta lies approximately 18 miles northeast of the Scapegoat Wilderness and is about 650 ft lower in elevation than the lowest portion of the wilderness. The continental type climatic pattern strongly influences the weather at this station. The station is a NWS recording location.

Section 3.2.1.1 **Precipitation**

An 84 year (1901-1988, several years are incomplete) average Water Year precipitation at Augusta is 13.79" (35.02 cm) with extreme years of 5.52" (14.02 cm) in 1919 and 23.28" (59.13 cm) in 1909 (Figure 23). The 1988 season closed with only 7.80" (19.81 cm) and was the 79th driest year on record. A return period of between 10 and 20 years was calculated for the 1988 Water Year total. Since the turn of the century this station has shown a declining trend in Water Year precipitation of -2.2" (5.5 cm). During the recent 25 year period 1961-1985 precipitation was -.86" (2.18 cm) below average. This below average value remained constant for the 28 year period extended to included 1988. From 1901 through 1958 the precipitation at this station can be characterized by wet cycles extending from 8 to 21 years with intervening dry

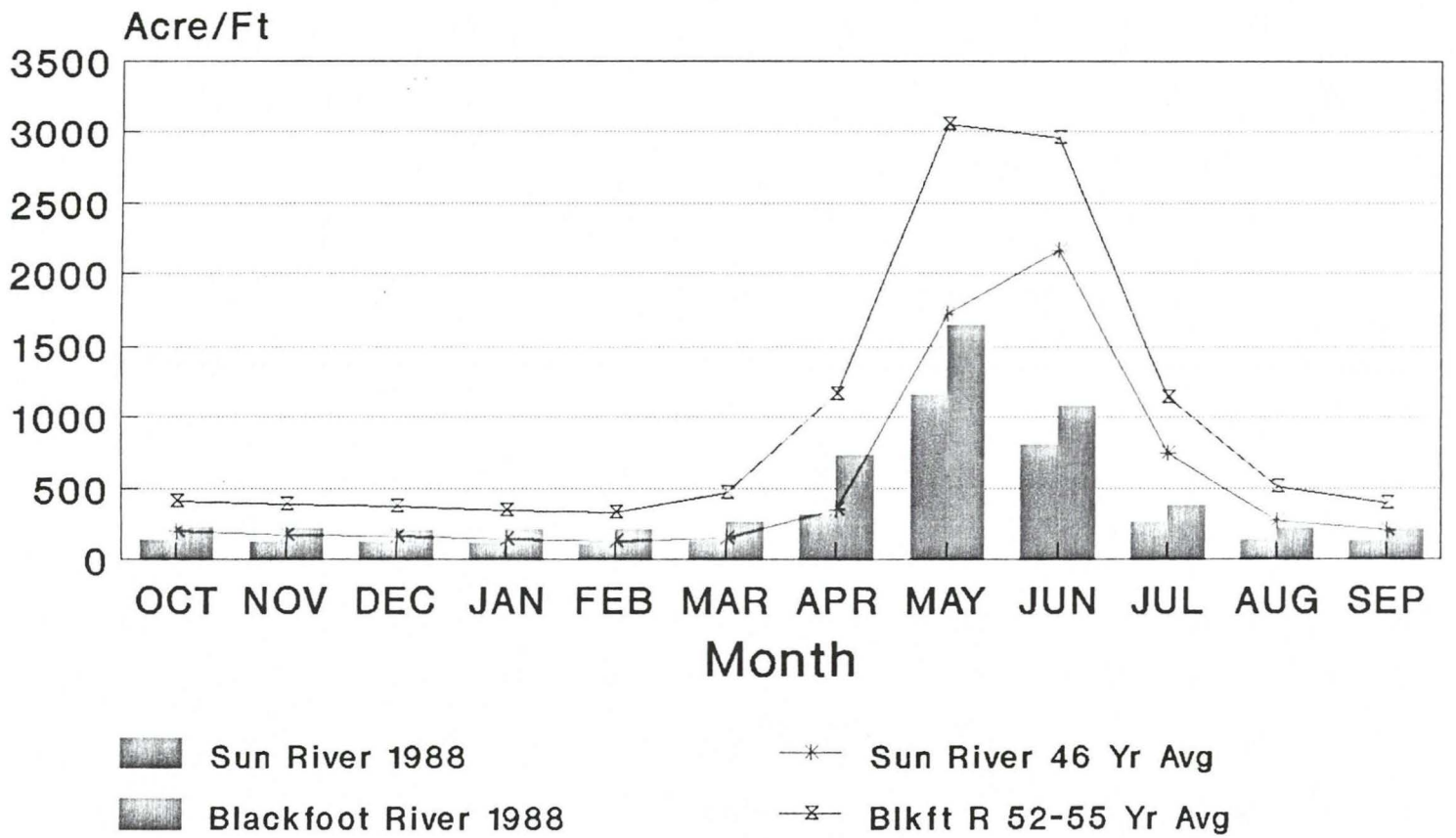
cycles from 3 to 9 years in length. From 1959 on the pattern becomes increasingly irregular fluctuations with seldom more than 2 or 3 years on either side of average at a time. During this later period there has been a greater tendency toward dry years. Since 1975 the pattern has become very irregular with 1988 being the driest year.

Pre-fire season precipitation in Augusta is not presented because this station is not a real good comparison to conditions within the wilderness.

Figure 22. Comparisons of the 1988 Water Year (October - September) stream flow from the Sun River and Blackfoot River with their historical monthly average.

Stream Flow

Drainages from the Canyon Creek Fire

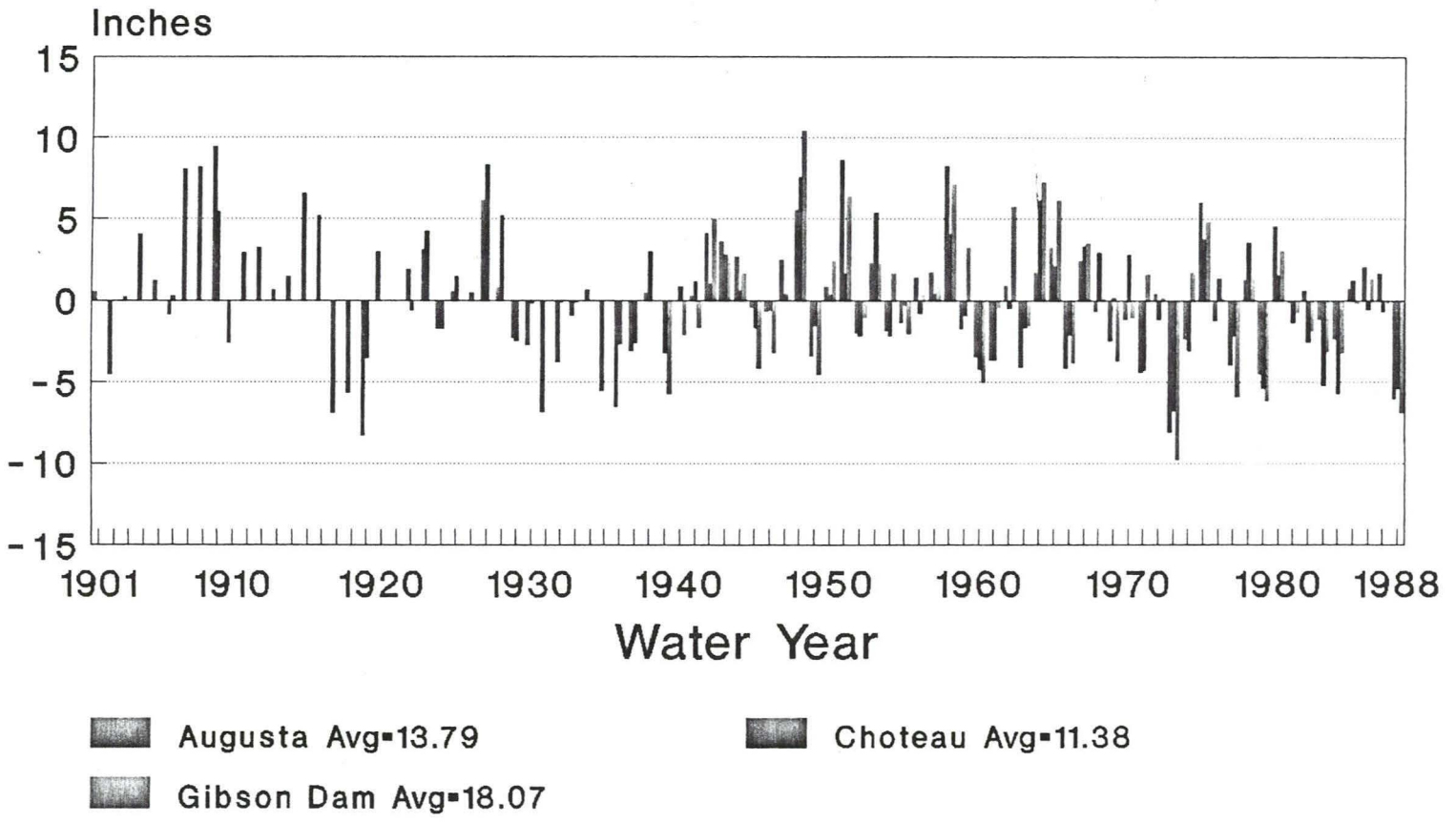


Canyon Creek Fire (1988)

Figure 23. Water Year (October - September) difference from average precipitation totals for the Augusta, Choteau, and Gibson Dam stations.

Water Year Precipitation Total

Difference from Average



Stations east of the Continental Divide.

A more applicable east side station will be presented covering all seasons. Precipitation during the summer fire season at Augusta averages 5.47" (13.81 cm) with extremes of 1.15" (2.92 cm) in 1919 and 13.78" (35.00 cm) which fell during 1958. The 1988 fire season ranked as the 85th driest (1.47", 3.73 cm) out of the 87 year period of records, with a return period of between 10 and 20 years. Only 27% of the total fire season precipitation fell during June of 1988, normally Augusta's wettest month.

An average of 6.86" (17.42 cm) has been received during the extended fire season with extremes experienced of 1.85" (4.69 cm) in 1935 and 14.92" (37.89 cm) in 1909. The 1988 season turned out to be the 79th driest season in an 87 year history with 3.02" (7.67 cm) received. August was the driest month during that period, receiving only 11% of the total precipitation; and was followed closely by the month of June with only 13%. September received 51% of the moisture.

During the month of June, Augusta has an average of 5 days during which it may receive 0.1" (0.25 cm) or greater of 24 hour precipitation. From July through September the average number of days that receive this amount of moisture drops to 3 within each month.

Section 3.2.1.2 Reservoir Storage

The Nilan Reservoir is located 5 miles west of Augusta and was one of the few bodies of water in close proximity to the Canyon Creek Fire. This reservoir was being maintained at higher than normal storage levels throughout the first 7 months of Water Year 1988 and does not accurately reflect precipitation totals for the area. Starting in May the storage level fell below normal, and rapidly dropped to well below normal levels (Figure 24). Because of the artifically maintained water level the 1988 Water Year was ranked as 8th out of 34 years of storeage level.

Willow Creek Reservoir is located about 4 miles northwest of Augusta and has a period of record covering 52 years. 1988 water levels (not graphed) at this reservoir were also maintained at above average levels until June. Levels stayed below normal for the rest of the 1988 Water Year. A rank of 34th out of 52 was given the 1988 Water Year storage level at the Willow Creek Reservoir.

Section 3.2.1.3 Temperature

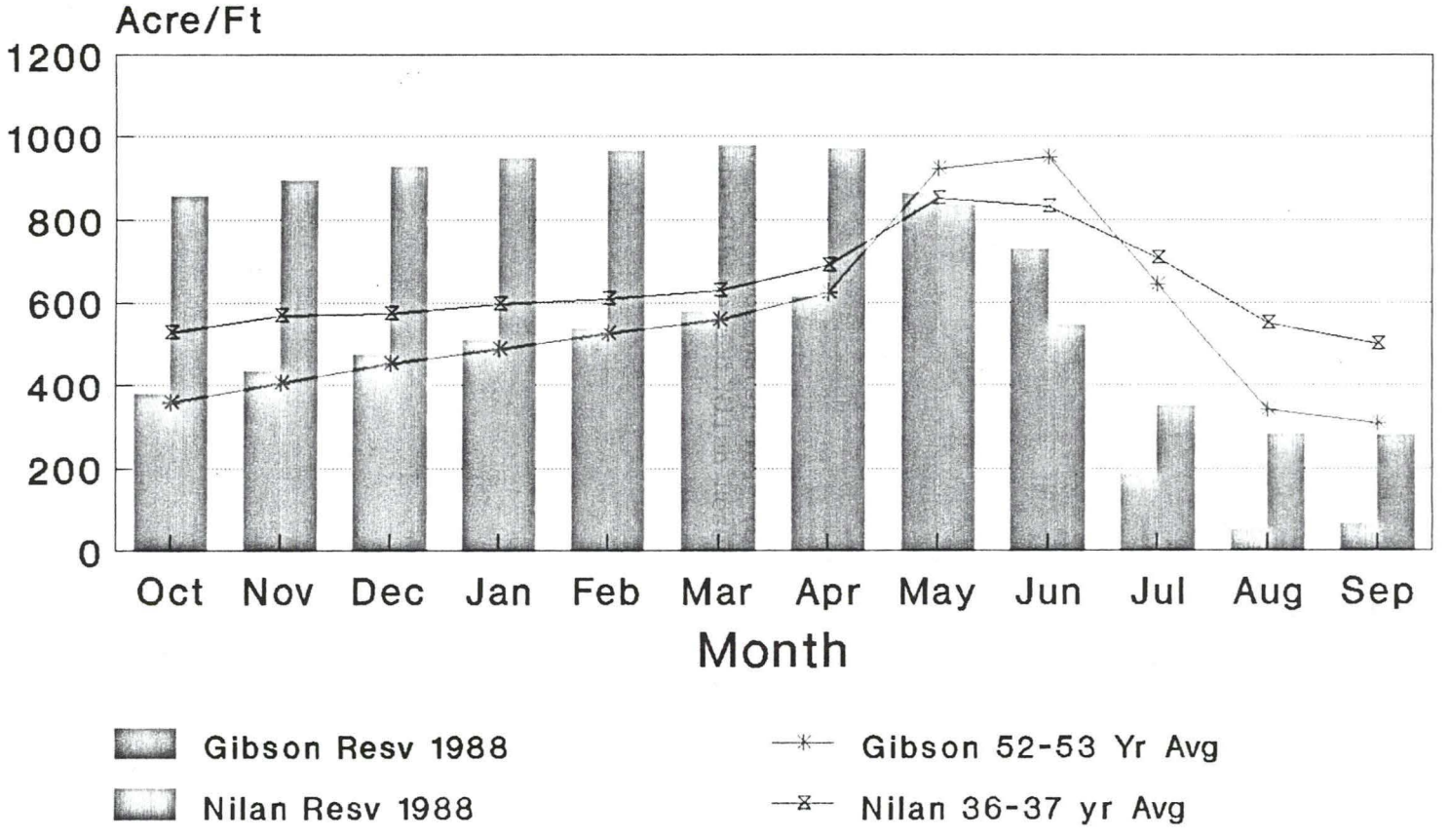
There is a 50% probability that the last killing frost of the spring will occur in Augusta later than May 15th. By June 2nd there is only a 10% probability of experiencing this cool of temperature. The first killing frost of the fall season has a 10% probability of occurring earlier than September 1st, and a 50% probability of occurring earlier than September 18th. This station has an average annual temperature of 43.1F (based on 1899-1988 records), and an annual maximum temperature of 57.1F. July experiences the highest average daily maximum temperature of 81.8F, followed closely by August with 80.3F. September average daily maximum temperature is considerably cooler at 69.9F. Extreme daily maximum temperature has been 103F. During July there is a 20% probability that at least one day will have a temperature of 97F or greater, and during August the same probability for a temperature of 96F.

Nearly the entire 1988 Water Year saw above average monthly temperatures in Augusta (Figure 25). November through January were exceptionally warm. A return to exceptionally high average monthly temperatures occurred in March and peaked in June with a difference from average of +7.4F. July through September, the warmest time of the year were closer to average, ranging from

Figure 24. Comparison of the 1988 Water Year (October - September) reservoir storage in the Gibson and Nilan Reservoirs with their historical monthly average.

Reservoir Storage

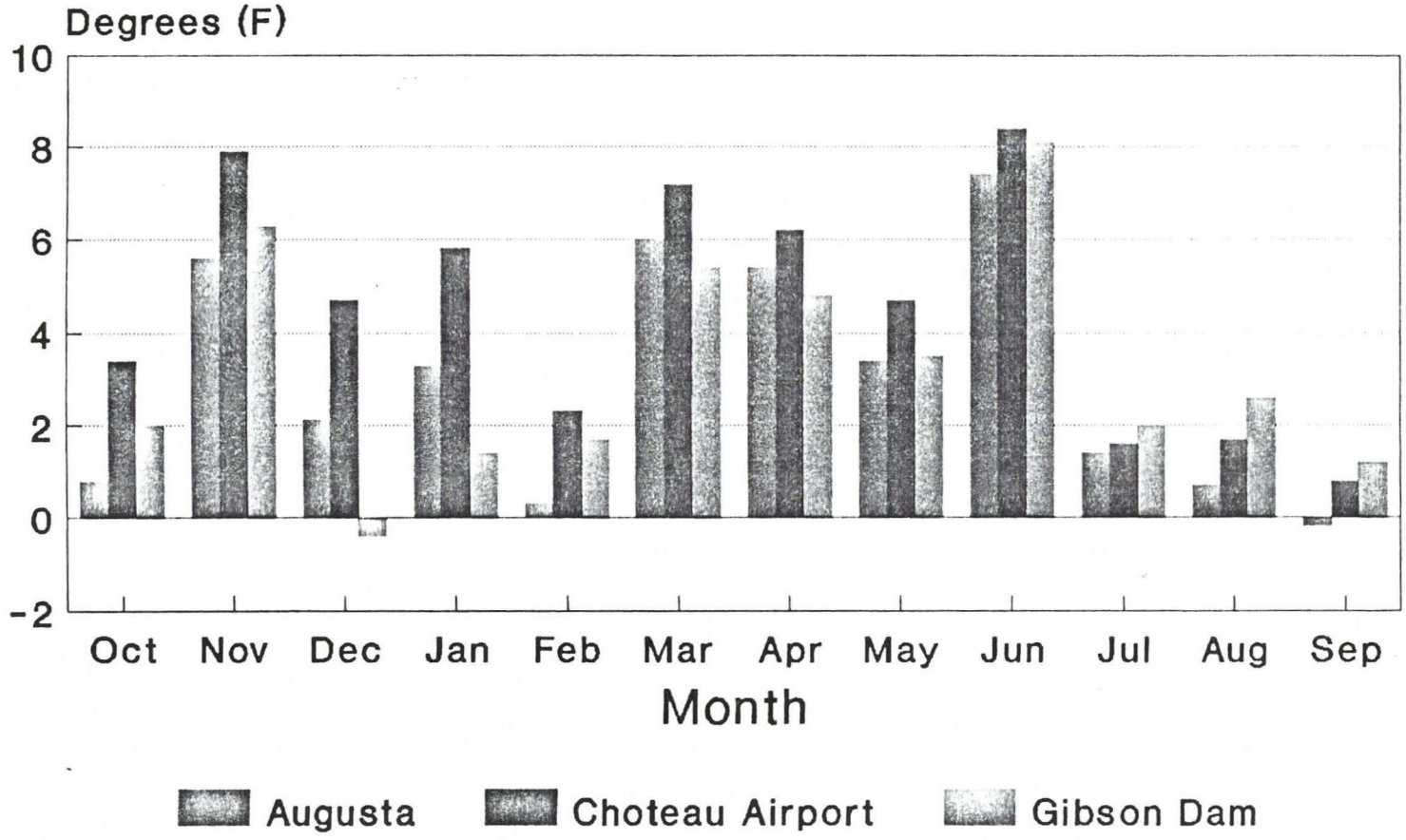
Storage from the Scapegoat Wilderness



East of the Continental Divide.

Figure 25. 1988 Water Year (October - September) difference from average of the average monthly temperatures at the Augusta, Choteau, and Gibson Dam stations.

Average Monthly Temperatures
1988 Water Year Difference from Average



Stations east of the Continental Divide.

+1.4F in July to -0.2F in September. The 1988 Calender Year average annual temperature eventually was +2.8F greater than average.

Section 3.2.2 GIBSON DAM, MONTANA

Gibson Dam is approximately 12 miles to the northeast of the Scapegoat Wilderness and is only about 120 ft lower than the lowest elevation within the wilderness. This station is within the borders of the Sun River Game Preserve on the Lewis and Clark National Forest and is more representative of climatic conditions within the forest east of the Continental Divide than are stations out on the plaines. Gibson Dam is a NWS data collection site.

Section 3.2.2.1 Precipitation

Water Year precipitation at Gibson Dam has averaged 18.07" (15.50 cm) during a 50 year period of records with extremes of 8.29" (21.05 cm) in 1973 and 28.22" (71.67 cm) in 1948. During the 25 year period between 1961 and 1985 this station has shown a declining precipitation trend of -.36" (.91 cm) below the long term average. Extending the period through 1988 (28 years) the decline is even greater, -.52" (.13 cm) with both 1987 and 1988 receiving below average moisture. The 1988 Water Year was ranked the 49th driest during the 50 year period with 11.18" (28.39 cm) of moisture with a return period of between 20 and 100 years.

The cumulative moisture received prior to the fire season at Gibson Dam averages 13.45" (34.16 cm). Extreme values received for the pre-fire season include a low of 6.12" (15.54 cm) occurring in 1977 and a high moisture value of 23.88" (60.65 cm) received during 1948. 1988 was ranked the 47th driest pre-fire season during the 50 year record at this station with 8.0" (20.32 cm) of precipitation. The return period of the 1988 pre-fire season was calculated to be between 20 and 100 years.

Fire season precipitation has averaged 6.29" (15.97 cm) with extremes occurring in 1973 with 1.41" (3.58 cm) and in 1948 with 14.27" (36.24 cm). The 1988 fire season ranked as the 48th driest (2.39", 6.07 cm) during the 50 years of records, with a return period of between 10 and 20 years.

With September included in the extended fire season the average precipitation increases to 7.98" (20.26 cm) with extremes of 2.65" (6.73 cm) in 1973 and 15.47" (39.29 cm) in 1948. Out of the 50 year record the 1988 season was ranked the 47th driest with 4.47" (11.35 cm) of moisture, and a calculated return period of between 5 and 10 years.

July is the month during which the least average number of days occurs of receiving 0.1" (0.25 cm) or greater of 24 hour precipitation during the summer months. June has an average of 6 days, while August and September each have 4 days.

A snow measurement station was located approximately 11 miles southeast of Gibson Dam and between 1 and 2 miles northeast of the wilderness boundary. This station, Wood Creek has been collecting data from 1979. During the winter of 1988 this station consistently had above average snow water equivalent measurements peaking in April. By mid-June there was no snow left to record which resulted in a below normal measurement.

Section 3.2.2.2 Stream Flow at Gibson Dam

Stream flow of the Sun River at the Gibson Dam is a result of precipitation received principally within the Bob Marshall Wilderness complex. Stream flow

at this site during the 1988 Water Year was consistently below normal (46 years of record). Peak flow months of May and June were well below normal. For the period January through September 1988 was ranked as the 45th lowest total flow over the 46 years, with a calculated return period of between 10 and 20 years.

Section 3.2.2.3 **Reservoir Storage Behind Gibson Dam**

In spite of the below normal streamflow of the Sun River the Gibson Reservoir was maintained at near average levels from October through May during the 1988 Water Year. Starting in June storage levels dropped below average and by July were well below average. Storage for the 1988 Water Year at this reservoir was ranked 42nd out of 52 years with a return period of between 5 and 10 years.

Section 3.2.2.4 **Temperature**

The last killing frost of the spring at Gibson Dam has a 50% probability of arriving later than May 15th, and a 10% probability of being later than June 1st. Similarly, the first killing frost after summer has a 10% probability of arriving earlier than September 9th, and a 50% probability of earlier than September 25th. The average annual temperature at this station is 41.7F (1948-1988 record), with a annual average daily maximum temperature of 53.8F. This station's average daily maximum temperature during the fire season is considerably cooler than the other east side stations. July is the warmest month with an average daily maximum temperature of 77.6F, followed closely by August with 76.8F. September's average daily maximum temperature is a relatively cool 66.8F. An extreme daily maximum temperature of 104F has been recorded. While August may have a slightly cooler average daily maximum temperature this month has a 20% probability of reaching or exceeding 93F, higher than a similar probability of hitting 92F or greater during July.

The pattern of average monthly temperatures at Gibson Dam followed a similar pattern to the Augusta station. Gibson Dam had a cooler December-January, followed by rapid warming in March with a difference from average of +5.4F. June experienced the greatest monthly departure from average during the Water Year with +8.1F. The normally warm July through September temperatures were slightly above average with the departures from average greater than the other east side stations examined. The 1988 Calender Year eventually ended up with an annual temperature +3.1F warmer than average.

Section 3.2.3 **CHOTEAU, MONTANA**

The Choteau station lies out on the plaines approximately 42 miles northeast of the Scapegoat Wilderness and is strongly influenced by the continental type climate. The elevation at this station is approximately 900 ft below the lowest elevation within the Scapegoat Wilderness. This station collects data for the NWS.

Section 3.2.3.1 **Precipitation**

The Water Year at Choteau has over a 67 year period (1905-1988, with a few incomplete years not included) averaged 11.38" (28.90 cm), with extremes having occurred in 1973 (4.61", 11.70 cm) and in 1927 (19.74", 50.13 cm). The 1988 Water Year received only 6.02" (15.29 cm) of moisture and was ranked the 65th driest year, with a return period estimated between 20 and 100 years. During

the 25 year period between 1961 and 1985 the average precipitation has been below the long term average by -.66" (1.67 cm). Extending the period out to include 1988, a 28 year period, with all three additional years receiving below average precipitation the declining trend becomes even stronger with a -.82" (2.09 cm) difference from the long term average.

The June-August fire season precipitation averages 5.32" (13.51 cm) with extreme measurements recorded of 1.79" (4.54 cm) in 1973 and 12.09" (30.70 cm) observed during 1948. The 1988 fire season had a total of 2.47" (6.27 cm) of which 52% arrived during June. This total ranked the 1988 season as the 69th driest out of 73 years of record for the season, with a return period of between 5 and 10 years.

Extended fire seasons at this location receive an average of 6.44" (16.35 cm) and have had extremes of 2.52" (6.40 cm) in 1971 and 12.60" (32.0 cm) during 1948. The 1988 extended fire season total moisture was 3.59" (9.04 cm) of which 31% arrived during September. This allowed 1988 to be ranked as the 67th driest extended fire season out of 73 years of records, with a return period of almost 10 years.

The station in Choteau averages 5 days in June during which the 24 hour precipitation total will equal 0.1" (0.25 cm) or greater of precipitation. The months of July through September each average 3 days of similar moisture.

Section 3.2.3.2 **Temperature**

The last and first killing frost in Choteau occur earlier and later, respectively, than they do in Augusta. This station has a 50% probability of the last killing frost arriving later than May 9th, and a 10% probability of later than May 24. The first killing frost after the growing season has a 10% probability of occurring earlier than September 11th, and a 50% probability of earlier than September 25th. The average annual temperature for Choteau was 43.6F with an annual average daily maximum of 57.0F (1898-1988 record). During July the highest average daily maximum temperature is attained of 82.4F, and also the highest average temperature of 66.3F. An extreme daily maximum temperature of 103F has been recorded. During July there is a 20% probability that a maximum daily temperature of 97F or greater will be reached. August has the same probability of attaining 96F or greater.

The 1988 Water Year average monthly temperatures at Choteau closely mirrored those recorded at both Augusta and Gibson Dam. In nearly all months though Choteau experienced slightly greater differences from the average than did the other stations. June had the warmest departure from normal of 8.4F during the Water Year. The 1988 Calender Year eventually ended with Choteau being +3.9F warmer than the annual average. The greatest difference from annual average of all the stations on both sides of the Continental Divide.

Section 3.2.4 GLEASON'S RESORT NFDRS STATION, MONTANA

The Gleason's Resort NFDRS fire weather station is located approximately 22 miles east-north-east of Choteau and about 32 miles from the Scapegoat Wilderness boundary. This station is the closest NFDRS station east of the Continental Divide to the Canyon Creek Fire and will be used to characterize east side conditions.

Section 3.2.4.1 **Precipitation**

From the NFDRS precipitation records (1962-1988) May receives the highest average monthly precipitation of 3.90" (99.06 cm) which declines sharply to a July low of only 1.80" (4.57 cm). The value for August rises slightly and then declines to even drier conditions during the months of September and October. The monthly extreme high precipition amount occurred during May 1962 when 7.72" (19.60 cm) fell, the monthly extreme low moisture amount was .01" (.02 cm) during July 1973 fire season. The ten day periods beginning September 1st and 21st, and October 1st and 21st receive on the average less than 0.5" (1.27 cm) of precipitation. The 1988 ten day periods starting on July 21st and August 1st receive record low precipitation totals of .00" and .01" (.02 cm) respectively. The frequency of occurrence of daily precipitation amounts at this station of greater than .20" (.50 cm) declines rapidly after the ten day period beginning on June 1st. The frequency of receiving moisture of this level increases slightly during both the August 11th and September 11th periods.

Section 3.2.4.2 **Temperature**

NFDRS monthly mean maximum daily temperatures peak in July at 74.9F, followed by August (74.3F) and June (70.5F)(measurements are for the years 1970-1988). During June 1988 the Gleason's Resort recorded the highest NFDRS monthly mean maximum daily temperature of 75.3F. NFDRS Mean maximum daily temperatures over ten day periods peak during the period beginning July 19th (77.2F). During 1988 three ten day periods established or tied the record NFDRS mean maximum daily temperatures, June 21st, July 21st, and September 1st. Record NFDRS maximum daily temperatures were set during the June 21st and September 1st periods. A record NFDRS extreme maximum daily temperature was recorded for the month of June 1988 with 91F. NFDRS maximum daily temperatures for the Gleason's Resort of 70F or greater may occur at anytime between the ten day periods beginning May 11 and October 11. Temperatures of 80F or greater also may be recorded from May 11 and can extend through September 21st. For NFDRS maximum daily temperatures of 90-95F the period is bimodal and extends from June 21st through July 1st, then follows a period of slightly cooler temperatures during which there has also been some 95F or greater measurements established during July 21st, then a return to 90-95F maximum daily temperatures from August 1-August 11. No measurements of 100F or greater have been established.

NFDRS monthly mean daily temperatures at this station peak in July at 59.1F, with August at 58.3F the second highest monthly mean. During June 1988 the highest NFDRS average monthly mean daily temperatures of 59F was established. The ten day period beginning July 21st has the highest NFDRS average mean daily temperature of 60.6F which is followed by the next ten day period being slightly cooler at 60.2F. Record ten day NFDRS mean daily temperatures were recorded during the 1988 periods beginning June 21 and July 21.

Section 3.2.4.3 **Relative Humidity**

The lowest NFDRS relative humidities (20-24%) measured from 1972 through 1988 occurred between August 11th and September 21st. RH's between 20-39% may occur at anytime between the ten day periods beginning July 1st and ending October 21st.

July has the lowest NFDRS monthly mean minimum RH value of 33.3%, followed by June with 33.9%, then August with 35%. The ten day period with the lowest NFDRS mean minimum RH starts on July 21st at 32.6%, followed by the subsequent ten day period with 32.7%. Extreme NFDRS daily low values were established in 1988 during the ten day periods beginning on June 21st, July 21st, and August 21st. NFDRS Minimum daily RH values below 20% may occur between the ten day periods of May 11-October 11. RH values lower than 10% have been recorded only during the ten day periods starting on July 1st, and on August 11th which has the peak frequency of occurrence.

The month of June has the lowest NFDRS monthly mean daily RH of 59.4% and these values climb steadily during the summer months. The ten day period with the lowest NFDRS mean daily RH starts with May 11th. This value fluctuates between the low and the highest value of 64.6% which occurs during the period starting October 1st.

Section 3.2.4.4 **Winds**

NFDRS winds during the extended fire season at Gleason's Resort average between 6.8 and 8.9 MPH with the greatest variability of range occurring during the month of September (average 4.2 MPH from the north - 10.8 MPH from the south, does not include calm periods). During June NFDRS winds of 8-12 MPH occur with a frequency of 25.8%, 13-18 MPH 11.2%, 19-24 MPH 3.5%, and greater than 24 MPH with a frequency of 0.2%. July NFDRS winds occur between 8-12 MPH with a frequency of 26.7%, 13-18 MPH 6.3%, 19-24 MPH 2.3%, and greater than 24 MPH 0.4% of the readings. NFDRS winds for August indicate that 28.8% of the readings fall between 8-12 MPH, 13-18 MPH 8.0%, and 19-24 MPH 1.8%, winds greater than 24 MPH occur with 1.0% frequency. September NFDRS wind measurements have 26.4% between 8-12 MPH, 13-18 MPH 9.6%, 19-24 MPH 4.1%, and greater than 24 MPH a frequency of 2.0%. This is the only station which had winds in excess of 24 MPH during every month of the extended fire season. Frequency for the stronger wind speeds were consistently higher than for other stations examined as well. October had the highest NFDRS wind measurements with an average of 8.9 MPH (average wind speed range of 4.5 MPH from the northwest and east - 10.8 MPH from the west). October winds between 8-13 MPH occurred 21.6% of the measurements, 13-19 MPH occurred 13.5%, 19-24 MPH 4.1%, and winds greater than 24 MPH had a frequency of 5.0%.

Section 3.2.4.5 **3-Way Co-occurrence of Extreme Burning Conditions and the Rxburn Program**

An examination of the prescription window used with the 3-Way program analysis of the Gleason's Resort stations AFFIRMS data of 75-95F, 1-30% RH, and 5-20> MPH for the months of June through September show July and August with the highest frequency of occurrence. The period of data examined included 27 years from 1962-1988. June data showed that the above combination with wind speeds between 5-9 MPH occurred with a frequency of 4.7%, 10-14 MPH had a frequency of 2.0%, 15-19 MPH a frequency of 0.2%. No June data for wind speeds greater than 20 MPH fell within prescription, expanding the prescription window to include temperatures of 50-79F and 21-70% RH produced a frequency of occurrence of 2.0%. July frequency of occurrence for data with wind speeds of 5-9 MPH was 15.9%, 10-14 MPH had 4.6%, 15-19 MPH was 0.1%. Again, July did not have data which fit the original weather window for wind speeds of 20 MPH or greater. Expanding the prescription window to include the same parameters with July extreme winds as was done with June produced a frequency of occurrence of

1.4%. The month of August had a frequency of occurrence with the original data window and 5-9 MPH wind speeds of 12.8%, 10-14 MPH was 3.0%, 15-19 MPH had 0.3%. Expanding the extreme wind speed prescription as was done with earlier months showed a frequency of 2.1%. September frequency of occurrence for the various combinations declined in nearly all wind speed categories. Frequency of occurrence for September combinations of the original weather window with 5-9 MPH wind speeds was 4.8%, 10-14 MPH was 1.6%, wind speeds of 15-19 MPH did not occur in prescription. This was the only month to have wind speeds of 20 MPH or greater fit within the September prescription window which had a frequency of 0.5%, expanding the window as above produced an increase to 2.4%. AFFIRMS data for this station covering the Canyon Creek Fire short-term catastrophic fire event on September 6, 1988 had readings of 79F, 22% RH, and 4 MPH wind speed (wind speed was slightly out of prescription by -5 MPH), and on September 7th the values were 61F, 25% RH, and 7 MPH wind speed. July had the highest percentage of occurrence of all weather prescription and wind speed combinations.

An examination of more restricted weather windows covering 3,222 days over 28 years during the 1951-1988 (38 year period) was accomplished with the Rxburn program. The preferred prescription of 80-95F, 5-20%, and 9-25 MPH had only a 1% occurrence, or a total of 31 days. July and August had the highest percentage of the 31 days with 35%; while in declining order occurred September with 23%, June 6%, and May failed to produce any days. In terms of the entire fire weather record for this station the data translates to frequencies of 0.34%, 0.34%, 0.21%, 0.06% for each of the respective months. This data could also be interpreted as meaning that for each month in chronological order there will be 1 day that meets the preferred prescription each 7.8 years for the month of June, July and August will each have 1 day each 2.4 years, and September will experience 1 day each 3.4 years.

An Rxburn program acceptable (parameters have a greater range) prescription of 75-95F, 5-25%, 9-25 MPH had a 2% occurrence (65 days) out of a total of 3,222 days of data. August had the highest percentage of days within this window, 40%. This was followed by July with 32%, September with 17%, and June having 11%. Again, in terms of the entire fire weather record for the Gleason's Resort station the days meeting the acceptable prescription were 0.80%, 0.65%, 0.34%, 0.21% for each respective month. Another way that this could be interpreted is for each month in chronological sequence there is 1 day each 2.2 years for June when the acceptable prescription window is met, July has 1 day each 1.2 years, August 1 day each 1 year, September 1 day each 2.2 years. May and October provided no days within the acceptable prescription window.

Section 3.3.0 Climatic Characteristics of Severe Fire Seasons and the 1988 Season

Finklin (1985) evaluated the climatic characteristics of severe fire seasons in the Northern Rockies between 1910 and 1984 and classified three types of seasons; Main, Early, and Late. The Main Type has its peak warm, dry conditions relative to normal around late July. An exception to this was noted for the area which includes most of the Scapegoat Wilderness where a broader and later peak was noted. Early Type seasons start with dry, warm May-June weather with precipitation approximately 50% below the normal. This season tends to end quickly with a change to above normal precipitation, which may then be followed by a return to dry weather and renewed fire activity. In the Scapegoat Wilderness area this early severe fire season peaks in late June or

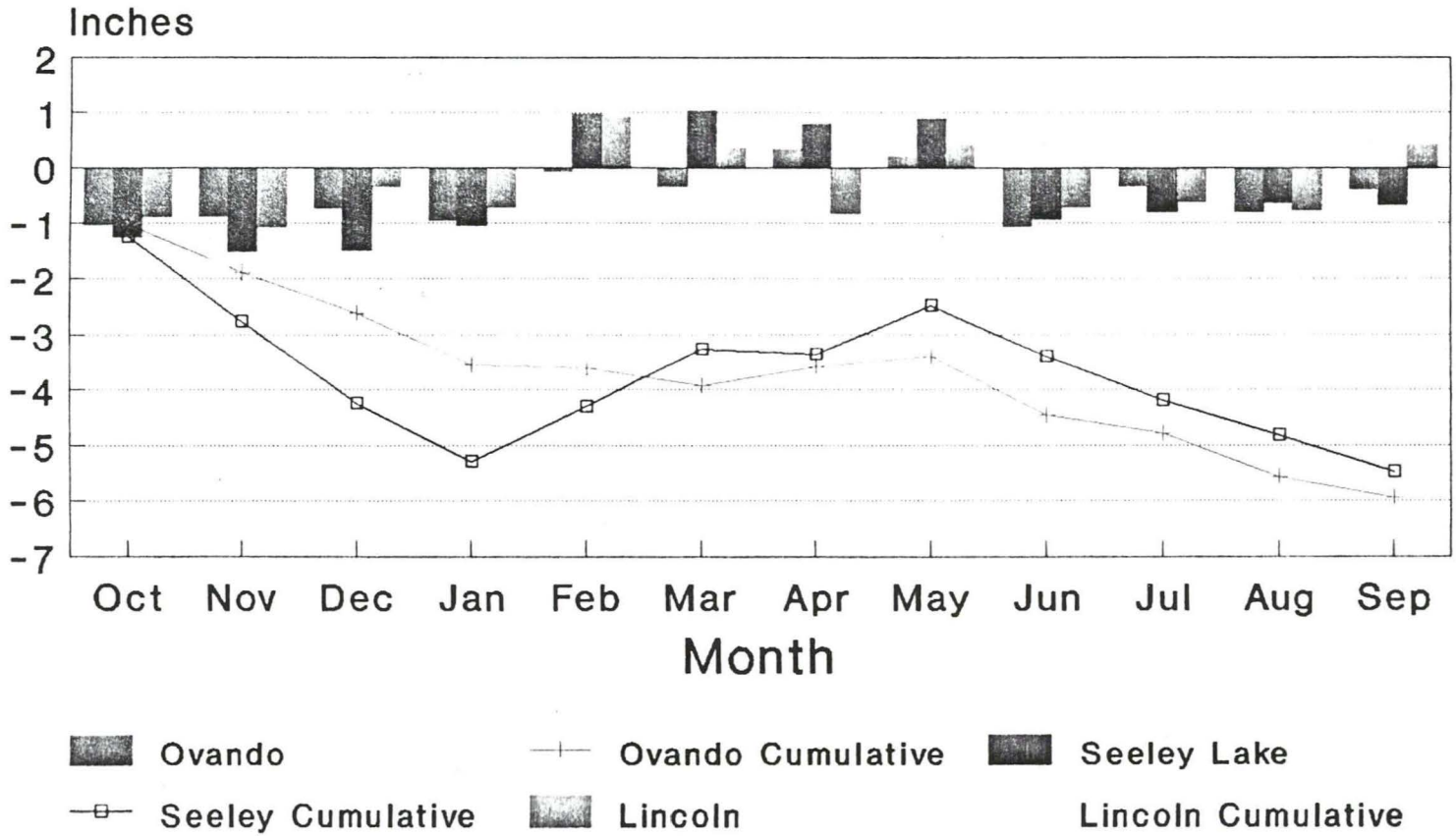
early July followed by rain. Severe fire seasons classified as Late Types frequently will have May-June precipitation averages up to 100% of normal with maximum temperatures being normal or slightly below. Warmer, drier conditions tend to peak in late August or early September. This type of season was found to be only marginally "severe" and of relatively short duration. After all three types of seasons there is usually a return to cooler and wetter than normal conditions by late September.

The 1988 season does not neatly fall into any one of the three severe fire season classifications. The 1988 temperature departures from average peaked in June at Seeley Lake and Lincoln Ranger Stations, then from July through September stayed near normal. Precipitation at the Lincoln Station was +19% of normal during May and -30% of average in June (Figure 26). Seeley Lake was +44% of normal in May and -41% during June. The temperature pattern would fit the potential for an Early Type severe fire season though May precipitation definitely did not. June moisture was not nearly the -50% that Finklin (1985) found in other Early Type seasons. East of the Continental Divide a similar pattern of very warm temperatures, normal to slightly below normal May precipitation, and well below normal June moisture was observed (Figure 27). However, a moisture deficit had been accumulating since the beginning of the Water Year at all stations (all stations west of the divide had been in a steadily worsening drought since at least 1985, east of the divide since 1981 with 1985-1987 close to slightly above normal). The Main Type season does not fit very well either because temperatures west of the divide returned to only slightly above normal, having peaked in June. However, July precipitation of -50% of normal at Lincoln and -76% at Seeley Lake does fit this severe fire season type. Again a similar pattern was evident east of the divide, and the Water Year moisture deficit at all stations was increasing. The Late Type doesn't fit because the early 1988 season was to warm and dry. The description of the later part of the Late Type season does fit in terms of accumulating dry conditions peaking in late August or early September. The return to wetter than normal conditions, as predicted by Finklin (1985), by late September did develop except at Seeley Lake and Ovando. The 1988 fire season included major parts of all three severe fire season types; early season peak temperatures above normal and an accumulating moisture deficit (even after above normal moisture levels from February through May at most west side stations), main season worsening drought, and peak late season drought conditions. In all respects the 1988 fire season in the vicinity of the Scapegoat Wilderness developed into an unusual "Extended Type" (author's term) severe fire season which started almost imperceptibly in June with drying conditions and abnormally high temperatures, then gradually becoming dryer and combining with normal to slightly above normal warm summer temperatures steadily worsening until reaching a peak in early September. The fire season then declined rapidly in severity but burning conditions would extend well into October.

Typically, Finklin (1985) found that during severe seasons there is at least one 30 day period between June 1st and September that will have less than 25% of the average precipitation for the period. Also, the 30 day maximum temperatures will average 5F to 6F above normal. The Lincoln Ranger Station during the month of June had a monthly average maximum temperature +5.5F above average, July was +4.9F. Average high temperatures for the periods June-August and June-October in 1988 would both have average high temperatures over +6F from average. As aready mentioned precipitation at this station was -30% of normal during June, and -50% during July. August moisture would be -60% of normal for the month.

Figure 26. 1988 Water Year (October - September) difference from average monthly precipitation totals, and cumulative deficit for the Ovando station, Seeley Lake Ranger Station (Lolo National Forest), and the Lincoln Ranger Station (Helena National Forest).

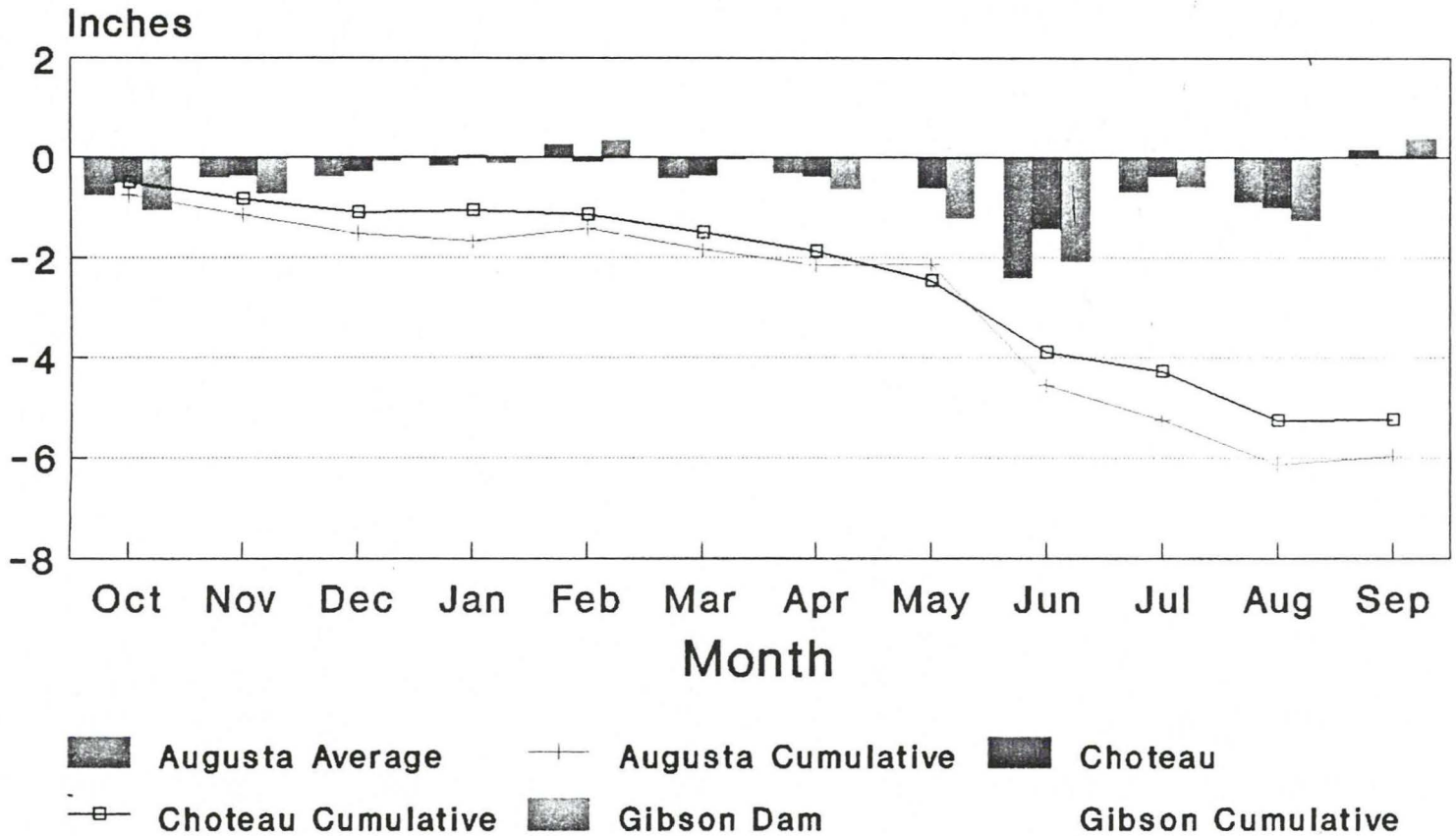
1988 Water Year Precipitation
Difference from Average



Stations west of the Continental Divide.

Figure 27. 1988 Water Year (October - September) difference from average monthly precipitation totals, and cumulative deficit for the Augusta, Choteau, and Gibson Dam stations.

1988 Water Year Precipitation
Difference from Average



Stations east of the Continental Divide.

Although Finkin (1985) did not examine the effect of dry, mild winter and early spring weather on the development of severe fire seasons, he does mention that early snowmelt and the drying of forested areas at his time of the year could be an important factor. A cover of snow did not arrive in much of the Scapegoat until early January of 1988 and was below average in snow water equivalent throughout the season. Warm late winter and spring temperatures removed what little snow had accumulated earlier than normal, exposing forest fuel to an extended drying season. Snow depth and moisture content, while being important, are not the principal factors affected the moisture content of large fuel particles. McCammon (1976) clearly found that it takes 150 days under continual snow cover for 1000 Hour fuel to attain maximum fiber saturation of approximately 39%. He also concluded that the duration of snowmelt is the major factor in liquid moisture absorption. Large fuel particles were already very dry following a warm, dry summer and fall in 1987 (AFFIRMS data and personal observations in the general vicinity). Assuming a snow cover from January 1st through June 15th at mid-elevations (Copper Camp's at 6950 ft msl was bare before June 15th) provides a snow cover for 166 days. The warm temperatures of February through June certainly hastened the duration of snowmelt which was already low in snow-water equivalent and at least at the Lincoln station below normal in depth. This would have allowed for an earlier than normal start to the large fuel particle drying process.

July was determined by Finklin (1985) to be the critical month in development of a severe fire season in the Northern Rocky Mountains. He found that 75% of the severe seasons examined in the Northern Region of the Forest Service had warm, dry Julys in respect to precipitation and average maximum temperatures. Only one season had a wetter and cooler than normal July. He also determined that few severe seasons had moist, cool Junes. The Canyon Creek Fire did not start to exhibit unusual fire behavior (different than previously observed within the Bob Marshall Wilderness complex during the Wilderness Prescribed Fire program) until the 23rd of July after burning for 28 days.

Section 4.0.0 **Fire Danger**

Fire danger is measured using several indices with input from the daily weather measurements taken at the different NFDRS stations (Deeming and others 1977). The NFDRS stations used to help describe the Scapegoat Wilderness climatology will be used again for comparison of the Fire Danger indices. In addition two other stations; Spotted Bear Lookout and Spotted Bear Ranger Station from the northwest corner of the Bob Marshall Wilderness complex will be include to gain a Fire Danger perspective covering the entire wilderness area. The indices Energy Release Component (ERC), Burning Index (BI), and Thousand Hour Fuel Moisture will be used.

The Energy Release Component is an index that calculates the estimated potential available energy released per square foot during the flaming combustion zone using standardized fuel models. An open ended scale is used to increase index sensitivity. Model characteristic surface area-to-volume ratio and weighted fuel moisture of the fuel bed are calculated using fuel class weighting factors based on loading (Bradshaw and others 1983). Day to day variations of the ERC are caused by changes in the moisture content of the various fuel size classes, including the larger fuel particles (Deeming and others 1977). The ERC for fuel model G is considered to be a good indicator of long term drying and is used as prescription guidelines in most manuals for prescribed natural fire prescriptions. These guidelines are usually discussed in terms of percentile level, as well as an actual ERC number. The percentile levels are calculated from frequency distributions of historical ERC levels. For comparison purposes the percentile levels are calculated in this report for the 1973-1987 seasons. This would have been data available at the time of the Canyon Creek Fire prescription decision process. NFDRS records prior to 1973 were not used because the weather records are incomplete. At some stations this information has been artificially generated and can produce misleading and inaccurate results (Burgan, personal communication 1988). Through experience it has been learned that an ERC of the 80th percentile or greater will require more management for suppression than fires below that level. The 80th and 90th percentile levels are common guidelines within prescribed natural fire prescriptions. These two levels, along with the 97th and 100th percentiles are presented for each station. Comparisons are made with an average 3-day running mean, to smooth out irregularities, for the years 1973-1987 and with previous recent seasons classified as severe in the Northern Rocky Mountains; 1967, 1973, 1985, as well as the 1988 season.

Finklin (1985) found that severe fire danger seasons which he classified as an "Early" type typically reached the 70th percentile level by June 20th and the 80th percentile by July 1st. "Late" type seasons reached the 70th percentile by July 25th and the 80th between August 1st and 10th. The downward curves for all three severe season types he found to be similar after September 1-10. Finklin described the 1967 season as "Late" on both side of the Continental Divide, and the 1973 seasons he determined to be a "Main" type on the west side of the divide and not severe on the east side based on ERC. Based on the 1973 ERC levels at the Gleason's Resort NFDRS station, and using Finklin's system I would place that portion of the area east of the divide within a "Main" type severe fire season. Using Finklin's classifications for the last two seasons, and for only low elevation NFDRS stations, placed 1985 on both sides of the divide as an early season, and 1988 as both "Main" and "Late" types west of the divide and a combination of "Early, Main and Late" types on the east side. Examining only the high elevation NFDRS fire lookout stations,

all four severe fire danger years may be classified as late "Main" type combined with an early "Late" type seasons.

The Burning Index is an index related to the contribution of fire behavior to the effort of containing a fire (Deeming and others 1977). The BI is based on flame length; and the BI, flame length and fireline intensity are all interrelated. In 1978 the BI was scaled to be ten times the calculated flame length. Percentile levels for the 1973-1987 historical record are presented with the 3-day running mean for the average BI for those seasons. Comparisons of BI for the severe fire seasons of 1967, 1973, 1985 and 1988 are made.

Thousand Hour Fuel Moisture is an index of fuel moisture for large fuel particles, commonly called 1,000-Hour Timelag Fuel. These particles are described as 3-8" (7.62-20.32 cm) in diameter either on or near the forest floor, or no more than 4" (10.16 cm) below the surface. A factor of 1,000 hours is used as a guideline for these fuels to lose an approximate 66% of their weight in moisture. The Thousand Hour Fuel Moisture model is calculated each 24 hours using the maximum and minimum temperatures and relative humidities, and the precipitation (if any) duration. The Thousand Hour Fuel Moisture is calculated from a running 7-day average of the daily factors and the Thousand Hour Fuel Moisture at the beginning of the 7 day period. This index is considered to be a good indicator of the severity of a medium drought event (4-6 months duration) (Bradshaw and others 1983). A season minimum moisture level for Thousand Hour Timelag Fuel of 9% within Fuel Model G in the Northern Rocky Mountains is indicative of this type of drought event. It is highly unusual for fuel particles of this large size to drop to such low moisture levels. For ease of comparison the average 3-day running mean Thousand Hour Fuel Moisture was calculated using the same years as used with both the ERC and BI indices, 1973-1987. Comparison of the 1988 3-day running mean is made with the 1967, 1973, and 1985 seasons.

Fire danger varies from station to station over a geographic area, and fire danger indices such as ERC and BI are not necessarily comparable between stations; an ERC of 52 will not mean the same at Spotted Bear Ranger Station as the same index number at Lincoln Ranger Station. The Thousand Hour Fuel Moisture is a comparable index over geographic areas and a good indicator of short term drought. Differences of between 2 and 5% in Thousand Hour Fuel Moisture can be quite significant in the determination between a "normal" or "severe" fire danger season. Comparing the indices trends from the differing stations, and especially when they pass significant percentile or moisture levels or the length of time at or above particular index levels can provide a good indication of how fire danger varies over a large area. The 1967 season is a good example. It can be seen from the following fire danger index examples that although that season was rated as severe across the Northern Rocky Mountains, the season was gaged much more severe with increasing latitude. In many respects, though not as pronounced within the Bob Marshall Wilderness complex, the opposite becomes apparent for the 1988 fire season with a trend of increasing severity with decreasing latitude. And at all of the stations examined the 1985 season was rapidly progressing into an early season with the potential for record, or near record fire danger with numerous and increasing numbers of ignitions in progress before the season ending rains arrived about August 1st. The 1973 season would eventually be noted as a season of considerable potential with very serious burning conditions and low Thousand Hour Fuel Moisture content, but generally lacked ignitions over most of the Northern Rocky Mountains. Interestingly, all four severe fire Danger seasons at the only station evaluated east of the Continental Divide developed in to seasons with strong fire danger potential under the influence of the

Continental Type weather patterns. A greater affinity, or fire danger similarity, at the east side station is apparent between the west side stations of lower latitudes than to the more moist west side stations further north.

Section 4.1.0 West Side Fire Danger and Comparisons with 1988

Section 4.1.1 LINCOLN RANGER STATION, HELENA NATIONAL FOREST

Section 4.1.1.1 Energy Release Component

The average 1973-1987 3-day running mean at the Lincoln Ranger Station has a bimodal distribution with peaks occurring on August 5th (43.4) and again on October 10th (46.2)(Figure 28). The first peak arrives after a steady climb in ERC starting from a low occurring on May 31st (16.7). In between peaks there is a gradual decline of about 10 points. The 80th percentile for this time period is 49, while the 90th is 56. The 80th percentile used in the Scapegoat - Danaher Wilderness Fire Management Plan based on a more limited historical computation (1973-1982) for the Lincoln Ranger Station is 33 for the preseason (up to June 30) and 51 for the post season (after August 25). The 90th percentile for the management plan fire season (July 1 - August 25) is 62.

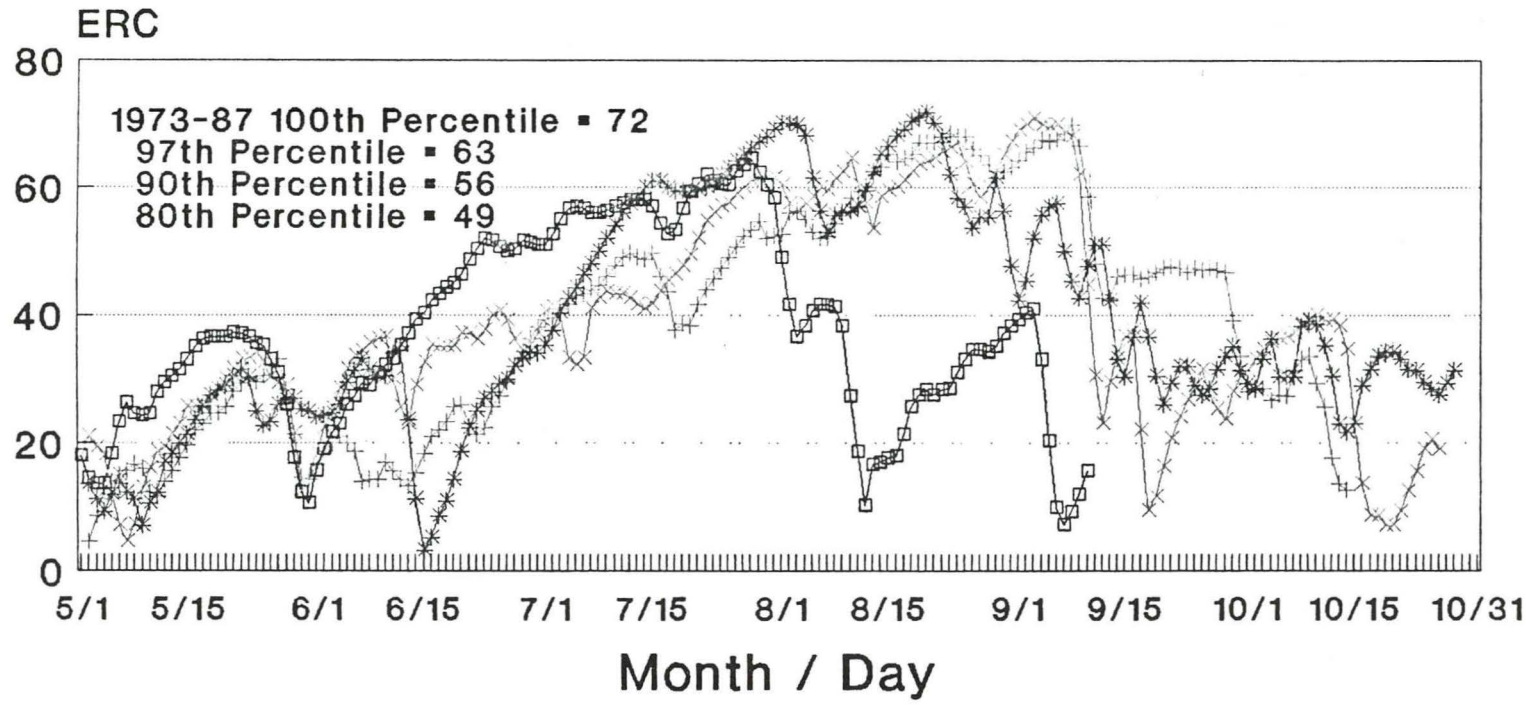
Only the 1985 severe fire season at this station had moved above the 80th percentile by the end of June. The 1985 season climbed rapidly and was well above the 90th percentile level when season ending rains began at the beginning of August (Bushey, 1985). Out of the years chosen for comparison the 1988 season was the second highest during the late June period. On the day of the Canyon Creek fire lightning strike, June 25th, the ERC level was 40.6. Although this value was above the 80th percentile level of 33 (1973-82 data base), the area's fire management plan provided for the fire's consideration as a prescribe natural start. All fires burning on or prior to June 30th, regardless of the ERC, require a Team Fire Impact Analysis. Decisions for these early season fires allow for adjustment of the ERC level based on previous experience with prescribed natural fires in the wilderness. By the date the prescribed fire decision analysis was signed, June 29th, the ERC had dropped down to 35.3, slightly above the 80th percentile, due to scattered, locally heavy rain in the area.

Shortly after the beginning of July the 1988 ERC level is at a point similar to the 1967, and 1973 severe fire seasons. Both of those previous seasons continued to climb in fire danger, while the 1988 season dropped slightly. When the 1988 ERC level started to recover it climbed steadily attaining the 90th percentile for the fire season as listed in the fire management plan on July 30th, and the 90th percentile for the 1973-1987 seasons on July 23rd. It is interesting to note that the preceding day, July 22nd, was the date the Canyon Creek Fire made its first large fire run covering approximately 8,700 acres. This was the largest single day fire run inside the Bob Marshall Wilderness complex since the prescribed natural fire program had begun. The largest previous fire run had been about 2,000 acres on the Charlot Peak Fire on July 21, 1985. Only on one later date would the Lincoln ERC level drop below the 1973-1987 90th percentile level.

All the severe fire seasons used in the comparison drop by various amounts during the first ten day period of August, and except for 1985 the severe seasons begin to climb to new heights. Severe season peak, or near peak ERC levels are reached during the third ten day period of August and are followed by another drop in ERC levels (this is earlier than the average ERC peaks during the 3rd ten day period of August). At this point in time the 1973

Figure 28. Energy Release Component for the Lincoln Ranger Station, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Energy Release Component
Lincoln Ranger Station (241904)



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season came to an end, leaving only the 1967 and 1988 seasons to again rebound. The 1988 season was above the 97th percentile level from August 19th through August 25th, and again from August 30th through September 8th. A peak ERC of 71 was attained on September 3, 1988. Both the 1967 and 1988 seasons are nearly identical in ERC levels as they enter the first ten day period of September, and both begin their precipitous end of the season drops about September 8th at this location. The 1967 season stayed above the 1973-1987 average into the fall, all other seasons which were tracked this late were either near the average or below. All remaining severe seasons recover to a limited degree during the later part of the first half of October helping to achieve the second peak in the 1973-1987 average ERC levels.

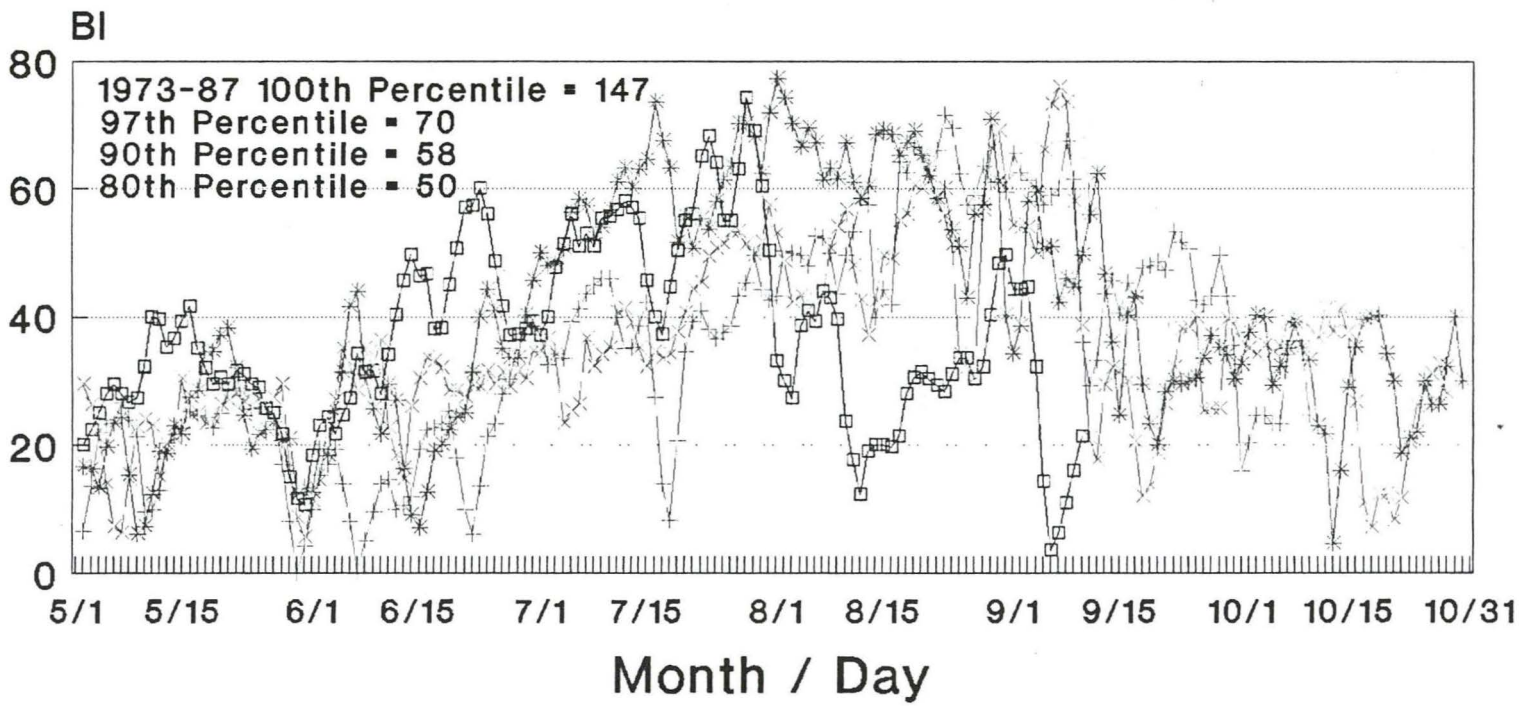
Section 4.1.1.2 Burning Index

The BI at the Lincoln Ranger Station fluctuates considerably under the influence of periodic wind events during the fire seasons (Figure 29). Most of these fluctuations are lost when the average values for the 3-day running mean of the 1973-1987 seasons is produced. The BI at this station is trimodal with peaks occurring on August 6th (44.2), August 27th (42.3), and October 3rd (50.1). BI variation surrounding the first two peak dates is minimal producing rounded peaks, rather than the sharp peak appearing later in October. BI is not used as a prescription guideline in the prescribed fire management plan, principally because of its day to day variability. However, percentile levels have been calculated using the 1973-1987 historical data. The 80th percentile level occurs at a BI of 50, while the 90th percentile is only slightly higher at 58.

During the early portions of the severe fire years only 1985 consistently climbed above the average BI. The 1985 index plummets during the first few days of August, as did the ERC level during that season, and remains near or below average the rest of the year. The 1973 season began to climb above the average season and separate from the remaining severe fire seasons on June 29th (40.0). That year was attaining peaks exceeding the 97th percentile as early as July 16th (73.6). The 1988 season BI remained near the average until July 21st (44.3) and climbed above the 80th shortly there after on July 24th (50.6). A short lived peak was attained on July 31st near the 90th percentile (57.3). It was at this time of the season that the 1967 severe fire season BI values started to consistently remain above the 1973-1987 average. The 1973 season remained above the 90th percentile throughout this part of that year. The second ten day period in August saw the 1967 and 1988 seasons finally climb above the 90th percentile level. The 1967 season stayed approximately between the 90th and 97th percentile levels until dropping on September 10th. The 1988 BI fluctuated considerably during these last time periods of the season. After scattered thundershowers in the immediate vicinity brought higher relative humidities and winds to the Lincoln Ranger Station on August 26th the 1988 BI briefly dropped back below average on the 27th (30.6). A rapid recover was made to above the 90th percentile with a return to lower humidities, then with calm to east afternoon winds the index again lowered slightly. With the approach and arrival of a strong cold front the BI reached its highest levels of 1988 on September 7th (76.0). Following this date both the 1988 and 1967 BI drop back to below average readings. The 1967 season would again attempt to regain some lost BI level, but 1988 never again had a sustained period above average.

Figure 29. Burning Index for the Lincoln Ranger Station, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Burning Index
Lincoln Ranger Station (241904)



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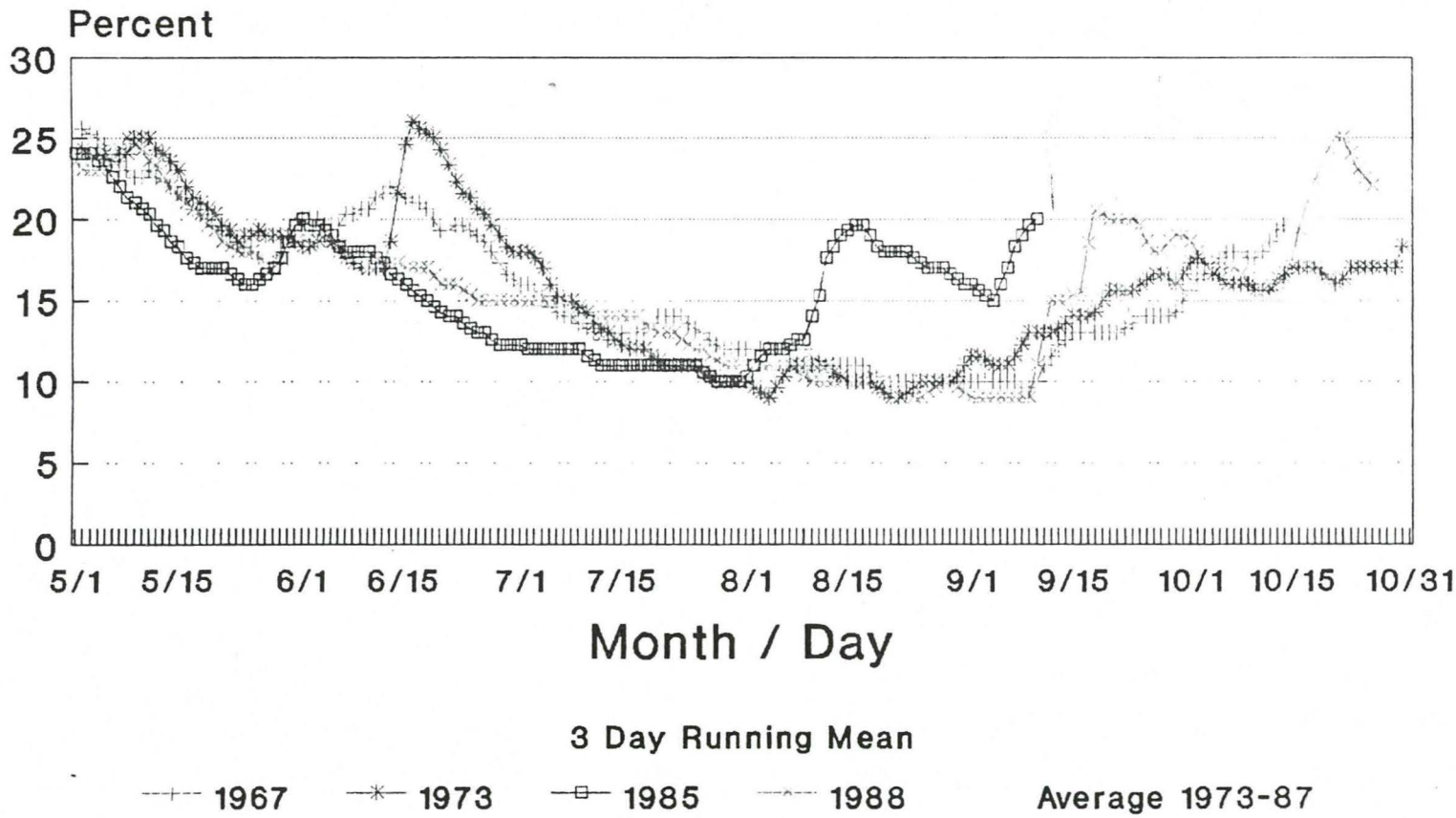
Section 4.1.1.3 Thousand Hour Fuel Moisture

Seasonal average Thousand Hour Moisture measurements at the beginning of May from the Lincoln Ranger Station are at the measured season high of 23.9% (Figure 30). Following a short period of decline the average season encounters approximately a month of higher moisture readings beginning about May 16th and reaching a peak May 26th (22.7%). After May 26th seasonal average moisture levels begin their summer decline at a gradual rate of approximately -0.1% per day. The seasonal average low moisture reading is attained on August 9th (13.8%). After the low reading, moisture levels increase at a rate of about +0.06% per day attaining a late season moisture peak of 16.9% on September 29th. There is a brief fall dry spell which again causes a decline in Thousand Hour Fuel Moisture values. These characteristic fall dry period lasts about fifteen days and brings moisture levels down to the seasonal average maximum low value of 13.2% before beginning to rapidly rebound.

Large fuel particle moisture readings for each of the severe seasons at the beginning of May are within 2% of the average for the 1973-1987 historical record. The 1985 season very quickly separated from the other severe fire seasons and rapidly begins a decline below the seasonal average for the time of year. The other three seasons experience a brief period above average then approximately May 21st these severe seasons cross to below average. During this period the large fuel particles normally experience an increase in moisture which is maintained until almost mid-June. Even during the severe seasons, Thousand Hour Moisture levels either level out or increase in moisture content during this late-May to mid-June period. The 1967 and 1973 seasons climbed above normal and took nearly half of a month to return back to average moisture content. 1988 gradually continued to dry at a rate of about -0.1% per day, while the 1985 season more rapidly declined in moisture at a rate approximately -0.3% per day. A maximum low of 10% moisture content in 1985 was reached on August 3rd, during this same time period in 1973 a similar moisture level was reached. However, during 1973 the moisture level would later drop to a maximum low of 9% during two separate periods, while during 1985 persistent rains raised the Thousand Hour Moisture levels back above the average. Both the 1967 (at a rate of approximately -0.2% per day) and the 1988 seasons would gradually continue to decline in moisture levels. A maximum low of 10% was finally reached in 1967 on August 19th and maintained at that level for 23 days. In 1988 a maximum low moisture level of 9% was reached on August 23rd, maintained for 4 days, then after a brief rise to 10% returned to 9% for another 10 days. For the severe fire seasons at the different NFDRS stations evaluated this was the second longest period of 9% or lower moisture content, and the longest period for a low elevation station. During 1988 there were 33 days when the Thousand Hour Moisture was 10% or less which is the longest extended period for moisture at this level or lower for any season or station examined. A return to more normal moisture levels in 1988 was more rapidly accomplished (a rate of about +1.3% per day) than during the other seasons which lasted as long as early September.

Figure 30. Thousand Hour Fuel Moisture for the Lincoln Ranger Station, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Thousand Hour Moisture
Lincoln Ranger Station (241904)



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Section 4.1.2 SILVER KING LOOKOUT NFDRS STATION, HELENA NATIONAL FOREST

Section 4.1.2.1 Energy Release Component

The record for the Silver King Lookout is understandably of shorter duration than lower elevation stations because readings are taken only when the station is manned (Figure 31). The 1973-1987 average can also be misleading since only 6 years are covered with a gap for the years 1974-1982 when NFDRS fire weather data was insufficient to produce fire danger measurements. The years classified as severe seasons in the Northern Rocky Mountains for the purposes of this report were recorded at the Silver King Lookout.

The average, 1973-1987 3-day running mean ERC at the Silver King Lookout tends to be irregular in its pattern with numerous small rises and dips as the fire season progresses though bimodal peaks in early August and early October. These minor seasonal fluctuations at the higher elevations are probably a reflection of a greater influence by weather patterns within the free air zone. It is of interest that they occur regularly enough at particular times of the season to produce the small rises and dips even when averaged. The 80th percentile level produced from the 6 years of data is at ERC level 44. Only during later parts of September and early to mid-October does the average ERC readings climb above the 80th percentile level, this is mostly due to a limited data set of between one and three 3-day running mean values during this time.

The 1967 severe fire season as measured by ERC was little different at this station than the average ERC measurements. The 1973, 1985 and 1988 seasons all depart from the seasonal average during the first ten day period of July, but it isn't until the second ten day period that all three severe seasons gradually pull away from the average ERC levels and approach or surpass the 80th percentile. ERC levels for the 1985 season declined in late July, several days earlier than nearby lower elevation stations, and never recovered. The 1973 and 1988 seasons tended to level off during the late July and first ten day period of August before resuming their climb to new ERC heights. The 1973 season peaked on August 19th at an ERC of 67.6, rounded that would equal the 100th percentile level. The 1988 season reached this point on August 30th, climbed to an ERC level of 74 from September 4th through the 6th establishing a new 100th percentile level for the historical records, then plummeted with the arrival of the season ending cold front. Several days of readings following the 6th are missing because the Silver King Lookout was abandoned for safety reasons following the short-term catastrophic fire event of the Canyon Creek Fire. The 1988 season after September 15th was below the seasonal average but recovered steadily as warm, dry weather returned.

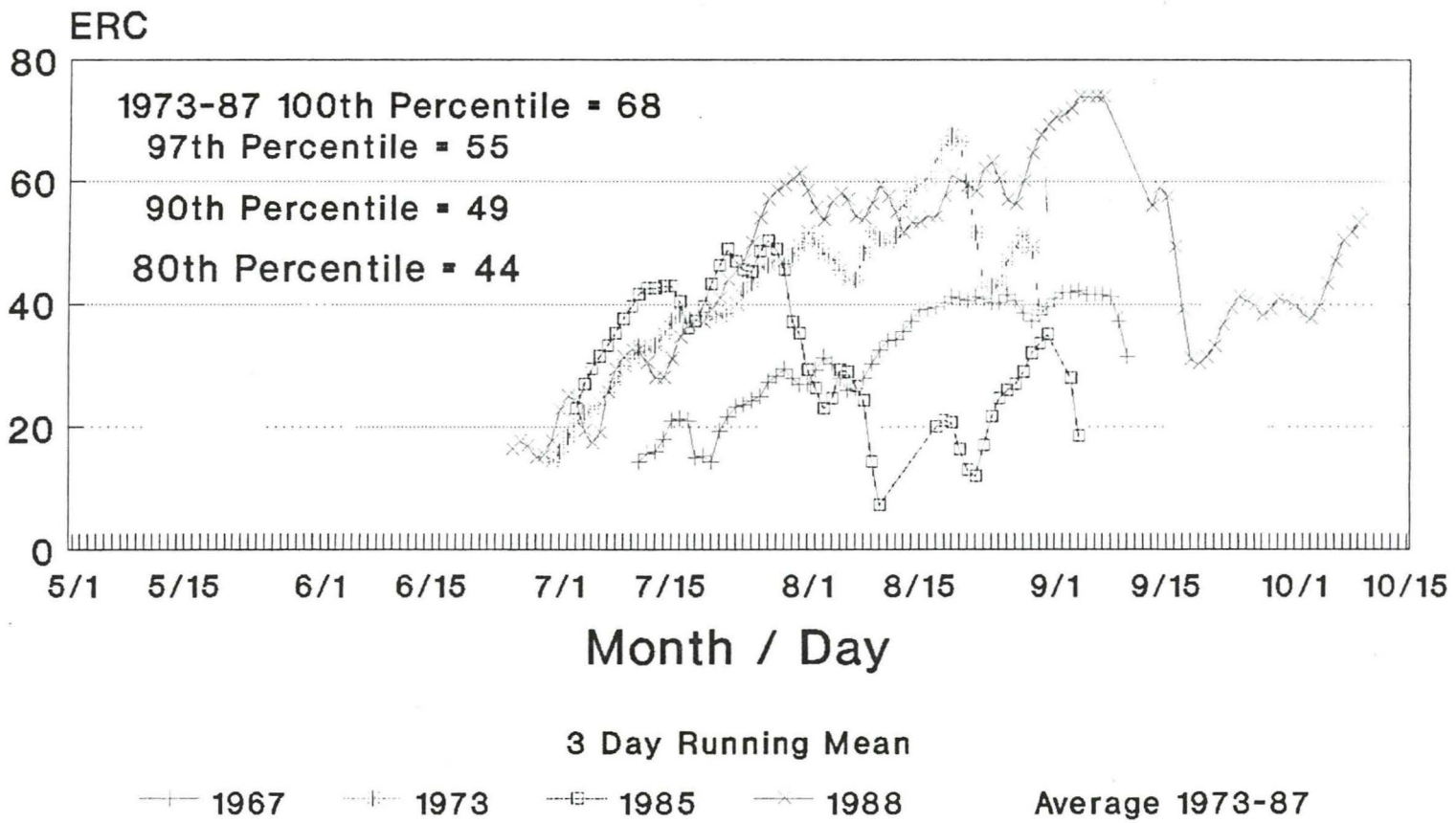
Section 4.1.2.2 Burning Index

The 1973-1987 (6 years covered) period for the average BI seldom approaches the 80th percentile level (58.0)(Figure 32). During the main part of the fire season average BI peaks are reached several times in August. Most BI readings over the 80th percentile level occur during the third ten day period in September or later. These late season levels near the 80th percentile are most likely artifacts of a limited data set for these last few days.

Individual severe fire danger years vary considerably at this station. the 1985 season never really got much above average BI until the end of August, by which time the fire season that year was well over with. In 1967 BI doesn't start to climb above seasonal averages until August 20th (62.3) and then

Figure 31. Energy Release Component for the Silver King Lookout, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

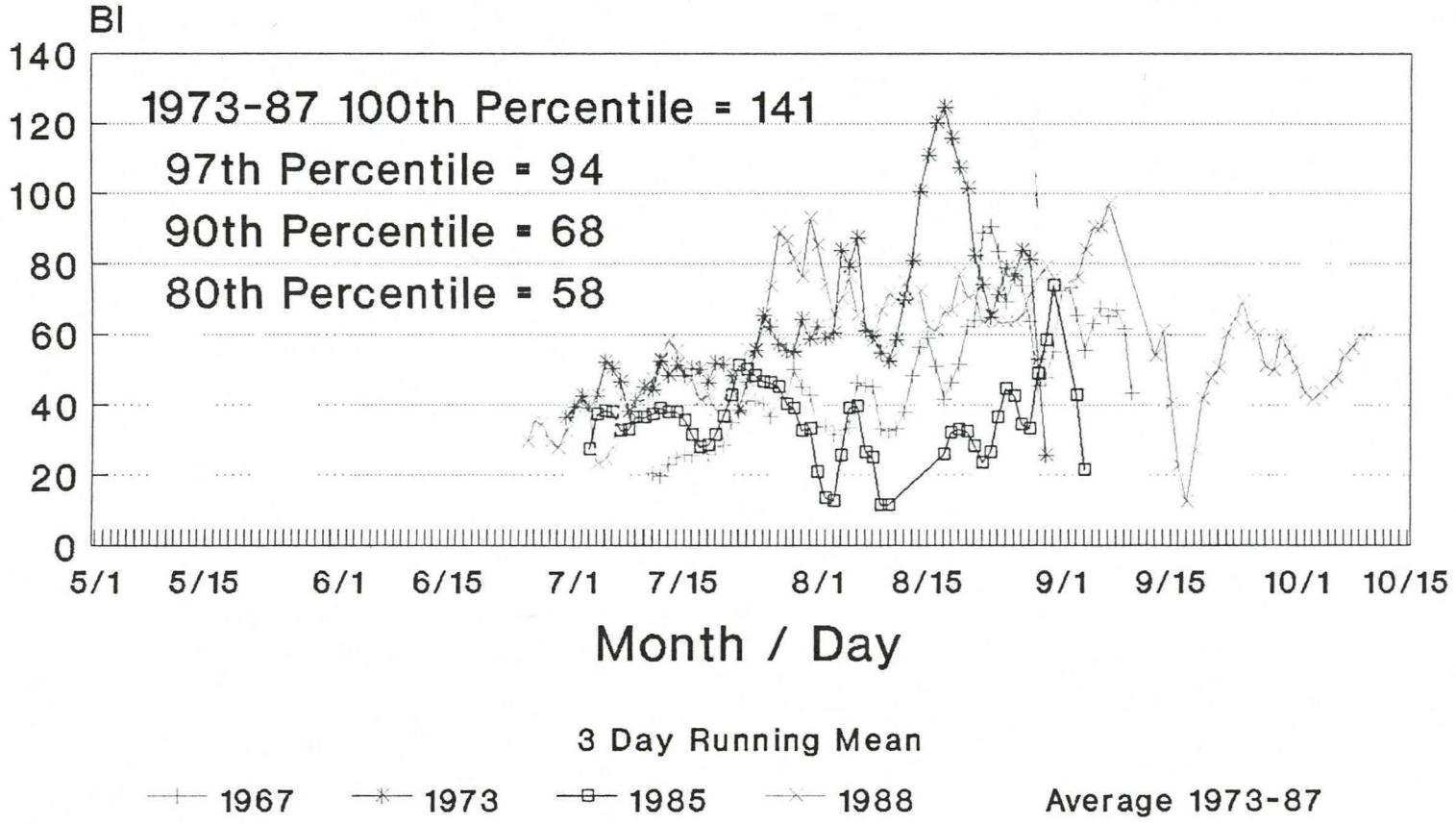
Energy Release Component
Silver King Lookout (241905)



C. Bushey/MPFS

Figure 32. Burning Index for the Silver King Lookout, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Burning Index
Silver King Lookout (241905)



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proceeded to climb to the seasonal high BI on August 26th (77.3). The 1973 and 1988 seasons showed BI values near or at the 80th percentile levels prior to July 15th. About July 23rd these years started to rapidly increase in their BI levels. In 1988 the 90th percentile was reached by July 26th, and the 97th percentile level approached on July 31st (93.0) before starting back down. In 1973 the 80th and 90th percentiles were attained later in the season on August 4th and August 14th, and climbed to a peak for the year on August 17th (124.6). The season peak in 1988 would not be reached until September 7th (97.0), long after the 1973 BI had fallen for the season.

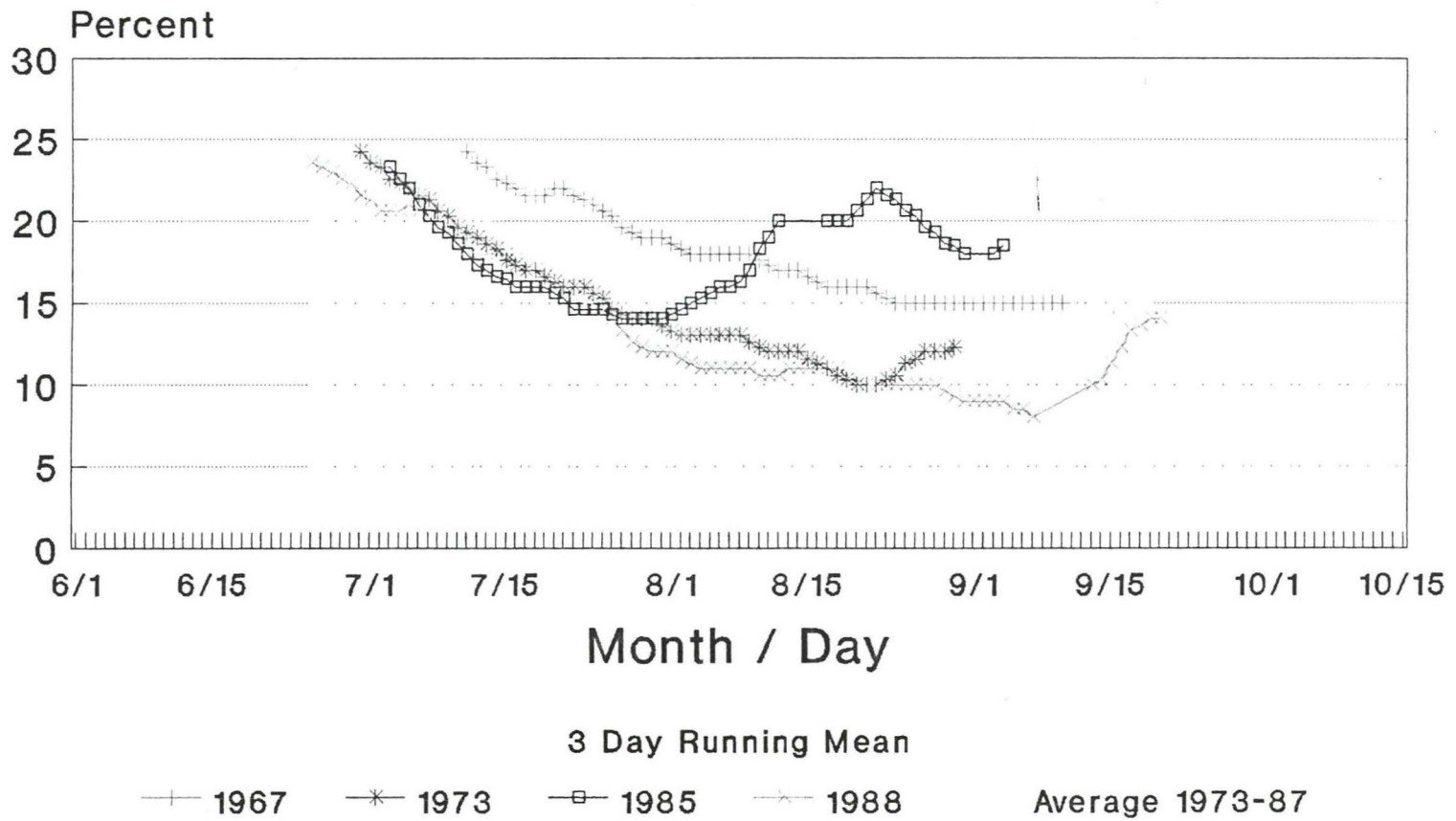
Section 4.1.2.3 Thousand Hour Fuel Moisture

For the 6 years of data at the Silver King Lookout the period of consistent seasonal records begins on June 25th with an average reading of 24% (Figure 33). From that date on this station experiences continual declines in Thousand Hour Moisture levels at a rate of approximately -0.2% per day. The average summer low moisture level is reached on August 5th at 15.4%. Following this low value a very gradual increase in moisture is experienced (about +0.1% per day) until September 7th when a late season high moisture level is reached of 18.6%. After September 7th a return to drying conditions extends into October and attains the seasonal average maximum low moisture reading on October 5th of 11.0%.

The 1967 severe fire season at this station was never far from the average Thousand Hour Fuel Moisture content and stayed above average until mid-August. The other three severe fire years started to fall below average during the first ten day period in July and followed very similar trends, declining at an approximate rate of -0.3% per day until about July 20th. At this point in time the 1985 season would level off then begin to climb with the arrival of an extended period of rains. The 1973 and 1988 seasons continued on persistent downward trends. 1988 reached moisture levels of 11% on August 3rd, fell briefly to a maximum low of 8% on September 7th and then climbed back toward the average for the season. The 8% reading was the lowest Thousand Hour Fuel Moisture reached by any NFDRS station surrounding the Bob Marshall complex in 1988. It was not the longest extended period at this moisture level when all of the severe fire years and stations are examined. The other high elevation station, Spotted Bear Lookout, had a longer period of 8% during 1967. A total of 23 days in 1988 had readings of 10% or lower, this does not include the five days when the station was abandoned and moisture levels climbed from 8 to 10%. The lowest moisture level reached in 1973 was 10% and only lasted for five days at the Silver King Lookout. Extended periods of Thousand Hour Fuel Moisture at such low moisture levels are a good indication of a strong, and sustained period of subsidence inversion occurring at the higher elevations.

Figure 33. Thousand Hour Fuel Moisture for the Silver King Lookout, Helena National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Thousand Hour Moisture
Silver King Lookout (241905)



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Section 4.1.3 SEELEY LAKE RANGER STATION, LOLO NATIONAL FOREST

Section 4.1.3.1 Energy Release Component

A distinct bimodal distribution is evident in the 1973-87 seasonal average ERC levels (Figure 34). A fire season ERC peak occurs on August 6th (36.4), and another peak can be found on October 10th (39.3). A steady decline in ERC levels occurs between these two peaks, with the later peak developing rapidly and being short lived. Using the 15 years of data between 1973-1987 established the 80th percentile at 37 and the 90th at 41. Only during the late season peak does the average ERC level surpass the 80th percentile, though the earlier peak almost equals it.

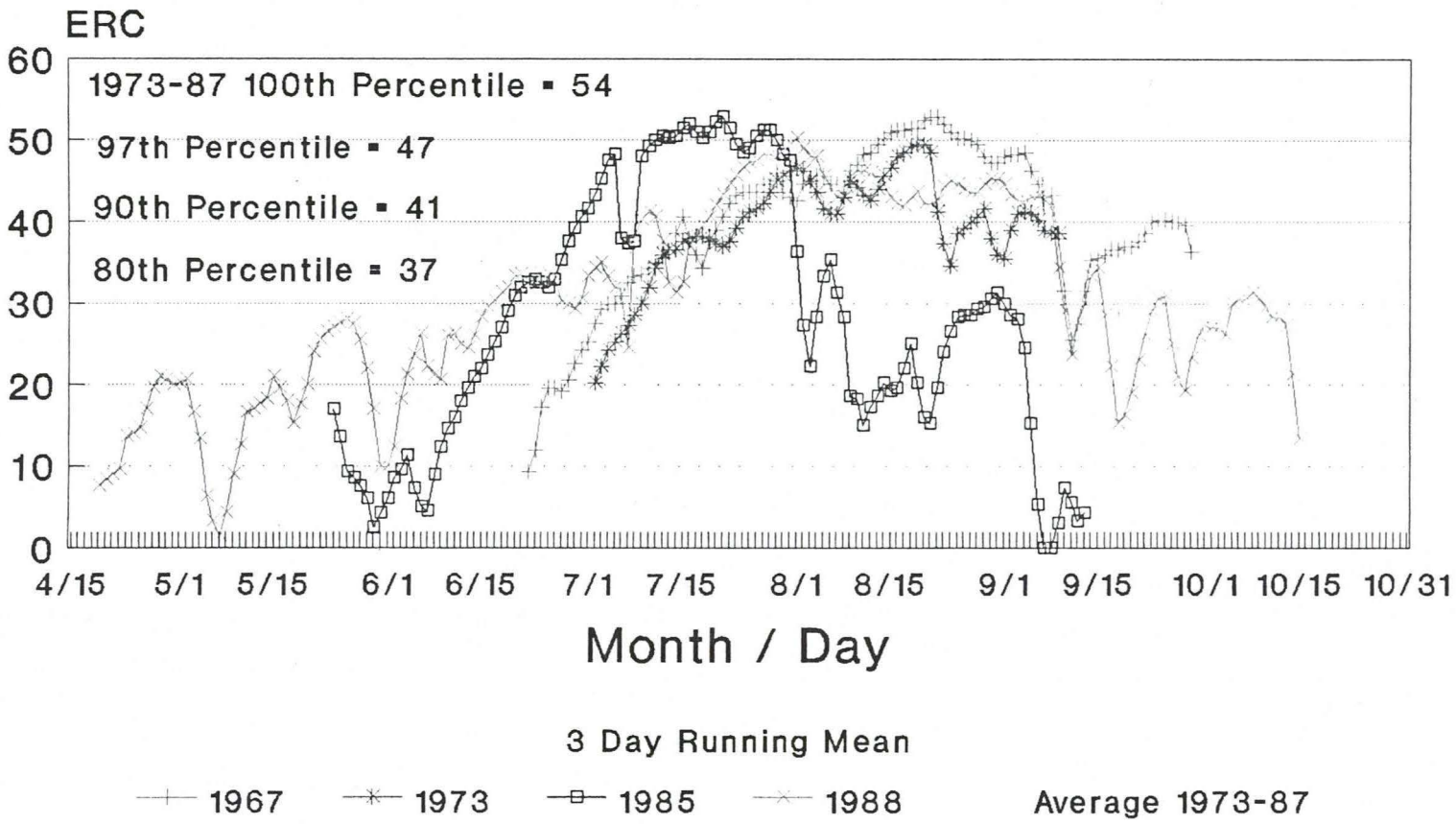
In comparing the ERC levels from individual fire seasons rated as severe and the seasonal average at this station it can be seen that each season first climbed above the average ERC level at differing times of the year. Such a wide distribution does not occur at any other station examined. The 1988 season first climbed above the average starting on May 21st (24.0) and appeared to be making an early season dash to high levels. However, the level peaked at an ERC of 28.0 and then declined back to the average. The return was brief as the 1988 ERC level again started to climb earlier and more rapidly than any other season examined. The 1988 ERC's leveled off on June 24th (33.6) only a few points below the 80th percentile level. The following day was the Canyon Creek Fire ignition by lightning. At this same point on the time scale the 1985 ERC level crosses the 1988 season, after climbing above the average starting on June 13th (19.6). The 1985 season gained more rapidly in ERC levels and reached a peak earlier in the season (July 21st, 53.0) than the other seasons selected for examination. The 1988 season, in spite of ERC fluctuations, gradually climbed higher rather than make steep gains as the 1985 season had. On July 8th the 1988 ERC level reached the 80th percentile (38.0) and two days later surpassed the 90th percentile (41.3). Curves for the 1988, 1967, and 1973 seasons all briefly met on July 13th. The 1988 ERC consistently stayed higher than these last two seasons until reaching a maximum high peak on August 1st (50.0) above the 97th percentile. After that date 1988 levels would very slowly decline while the 1967 and 1973 seasons moved on to later seasonal peak values. Just prior to the August 1st date in 1985 the ERC levels at this station started a precipitous decline. Sharp declines also occurred near the end of the 1967 and 1988 seasons, starting within one day of each other, September 9th and 8th respectively. The 1973 season readings also abruptly cease on September 9th, likely signaling a sharp end to the season and a feeling that further measurements would be a waste of time. A return to warm, dry conditions is indicated following the decline back to seasonal average levels. The 1988 late season ERC rebound is short lived, but both 1967 and 1988 indicate the possibility of continued burning conditions following significant precipitation events in late summer severe fire seasons.

Section 4.1.3.2 Burning Index

BI at the Seeley Lake Ranger Station has two principal peaks when the average 3-day running mean is examined for the 1973-1987 years (Figure 35). These peaks occur on July 31st (35.0) and in the fall on October 9th (46.3). Following the first BI peak there is a gradual decline of approximately 10 points reaching a low around September 10th, then a more rapid climb toward the short lived peak in October. The seasonal 80th percentile level was calculated to be 37, and the 90th percentile was 42. Only the peak during the fall

Figure 34. Energy Release Component for the Seeley Lake Ranger Station, Lolo National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Energy Release Component
Seeley Lake Ranger Station (241508)



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exceeds the 80th and 90th percentile levels for average BI.

The distinct separation of dates when the severe fire seasons passed above the seasonal average is again apparent at this station as it was for the ERC index. The 1988 season is the first of the severe seasons to break above the BI average, and except for some early brief periods was to stay above the average until September 10th. This was the longest above average period of any season examined at this station. The 1985 season is the next year to emerge above the average starting on June 12th (22.6). As was characteristic of 1985 for both ERC and BI at this station and others, a very rapid climb in fire danger was indicated. June 28th was the date in 1967 when BI started to exceed the average with a reading of 24.6. This index in 1967 also made an initial rapid climb and meets with the more gradually climbing 1988 season on July 2nd (30.3). The latest season to move above the average was 1973 at this station, emerging on the second day readings were collected, July 3rd (26.0). 1973 experienced a rapid initial increase in fire danger. About July 10th the 1967, 1973, and 1988 seasons have a period of relatively slow increases in fire danger. The period of slow increases in BI ends during the second ten day period in July when all three seasons begin rapid increases in index levels and move for a long extended period of time above the 90th percentile level. The 1985 season dropped back to below average on August 1st at this site. 1973 would attain the peak BI for the season on August 2nd (57.3). The 1967 season would continue climbing until a peak was reached on August 22nd (69.3). During the 1988 season a period of early high BI above the 97th percentile was attained between July 27th and August 4th (peak on July 27, 60.3), but the peak BI during 1988 would not arrive until September 6th (65.00). After a sharp decline in BI on September 3, 1967 that season returned to average for one day, then immediately climbed back up and remained above average the rest of the season. When the BI collapsed in 1988 there were only brief periods when the index succeeded in rising above the index average during September and October.

Section 4.1.3.3 Thousand Hour Fuel Moisture

The seasonal average Thousand Hour Fuel Moisture drops from a maximum high moisture level of 24.5% on May 30th and begins a gradual (approximately -0.2% per day) decline to the seasonal average maximum low value of 15.6% reached on August 10th (Figure 36). Following the lowest moisture value the season slowly regains moisture at a rate of about +0.05% per day until seasonal data collection ends with a level of 18.6%.

During the early portion of the 1988 season the Thousand Hour Moisture was either at, or above average at the Seeley Lake Ranger Station. On May 23rd the moisture curve for 1988 dropped below average with a reading of 20.6%. This was the earliest of any of the seasons examined for this index to drop below average for the remainder of the season. From this point the 1988 season would show a gradual decline in large fuel particle moisture levels (approximately -0.2% per day). The 1985 season didn't drop below average until June 18th (21.6%), but declined in moisture rapidly after doing so (approximately -0.6% per day). By June 28th the 1985 season Thousand Hour Fuel Moisture level had dropped as low as the more gradually declining 1988 season reaching 17.0%. The 1967 season would not drop below the average seasonal moisture level until July 4th (19.6%) and declined at a similar rate as the 1985 season. On July 13th in 1973 the moisture level at this station finally dropped below average (18.3%) and declined at a rate of approximately -0.3% per day. Also on July 13th during 1985 a plateau was reached of a near maximum low moisture level of 13%. Twenty-two days during 1985 would be at or slightly below the 13% moisture

Figure 35. Burning Index for the Seeley Lake Ranger Station, Lolo National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Burning Index
Seeley Lake Ranger Station (241508)

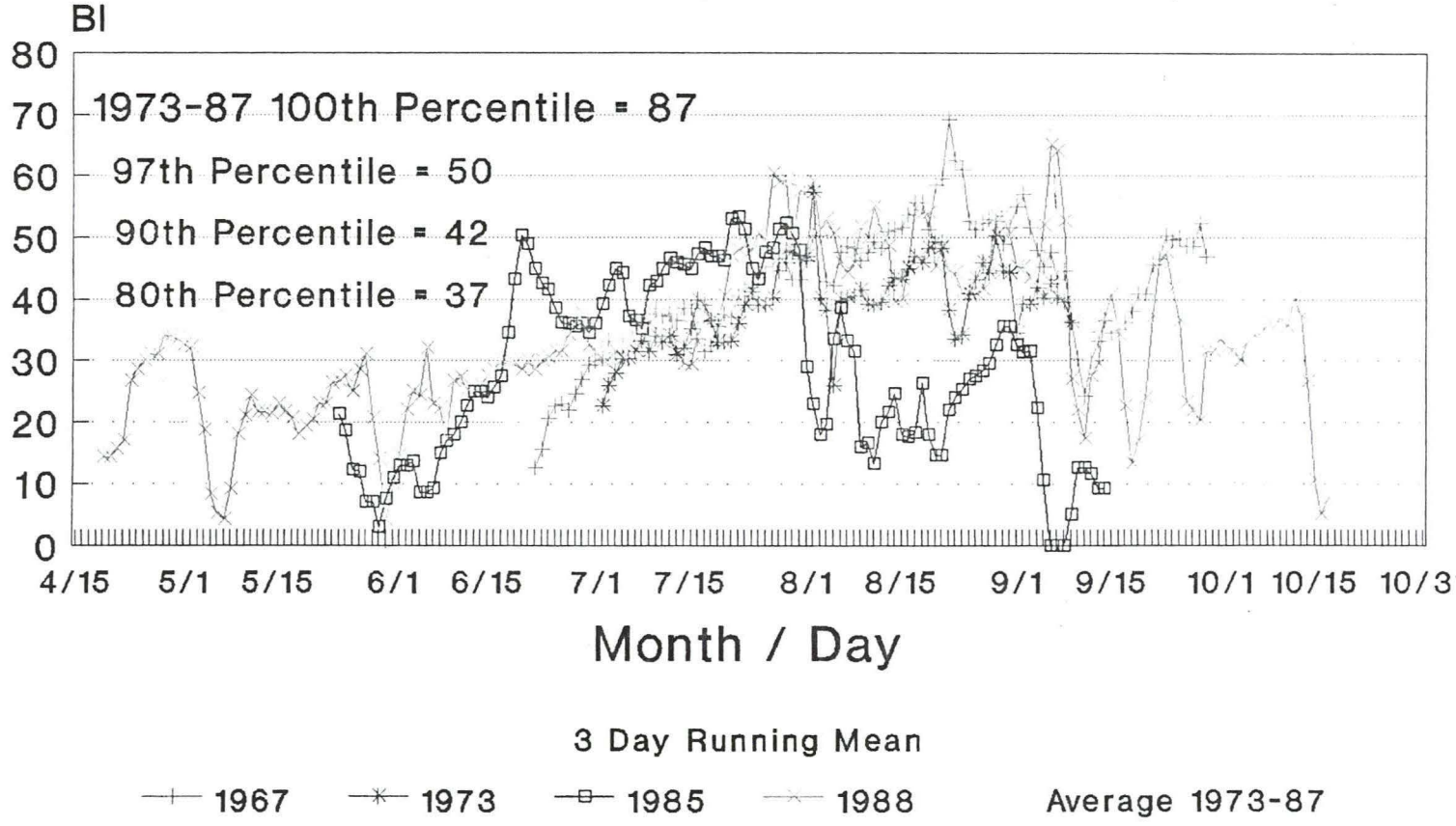

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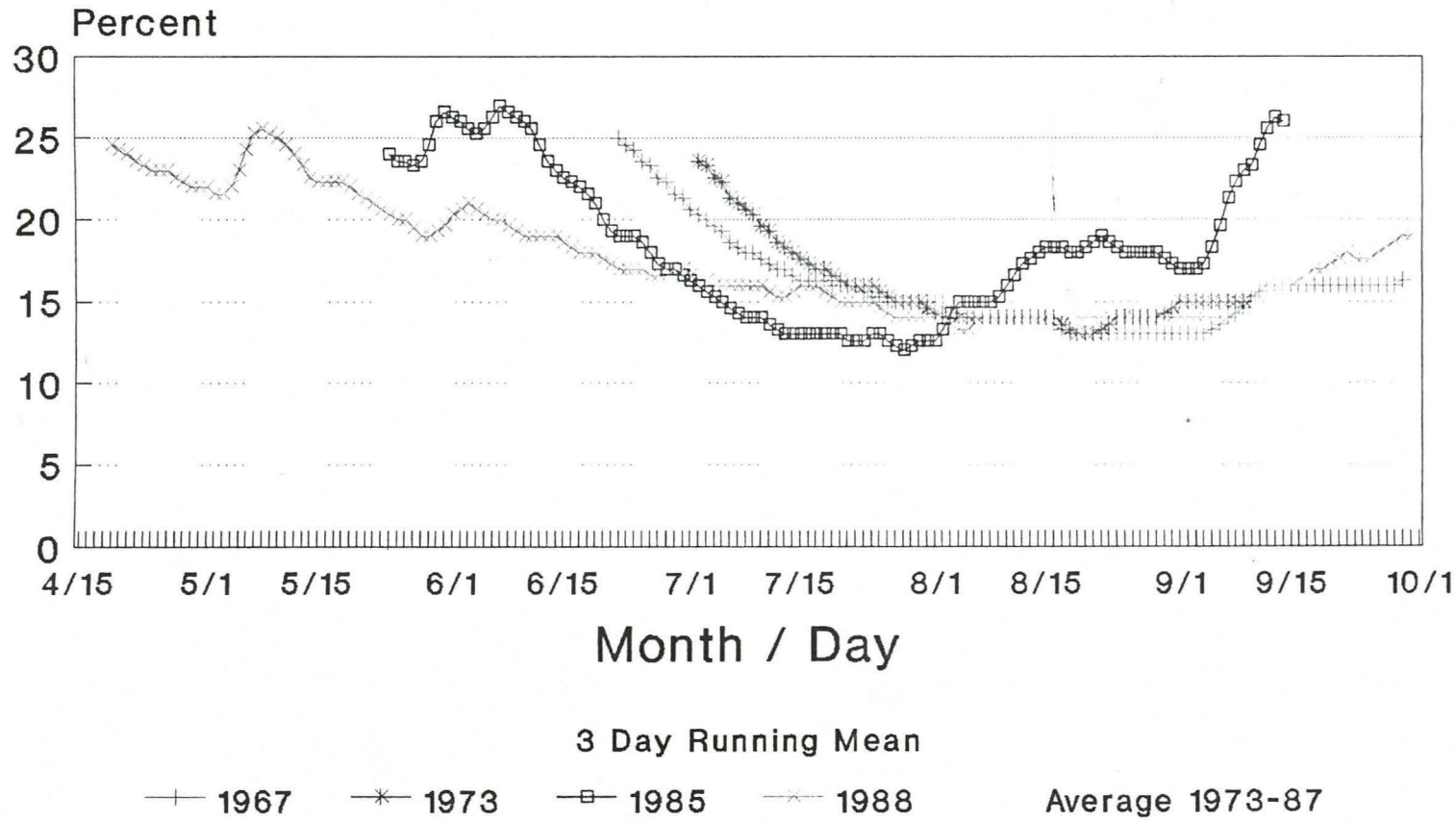
Figure 36. Thousand Hour Fuel Moisture for the Seeley Lake Ranger Station, Lolo National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Thousand Hour Moisture
Seeley Lake Ranger Station (241508)



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level which is the lowest level achieved by any other season for shorter durations at this station. A one day maximum low moisture level would be reached during 1985 of 12% on July 28th. After August 1st, 1985 moisture levels climbed rapidly achieving near average levels within seven days. A maximum low moisture level of 13.3% was achieved on August 4th and 5th during the 1988 season, for 43 days during that season moisture levels would be at 14% or less. During 1967 the maximum low moisture level of 13% was reached on August 18th and was sustained for a period of eighteen days, moisture of 14% or less was kept for 34 days. The 1973 maximum low moisture was also 13% but was maintained for only three days before starting a gradual recovery, 28 days would be spent with 14% or less levels.

Section 4.1.4 SPOTTED BEAR LOOKOUT NFDRS STATION, FLATHEAD NATIONAL FOREST

This station is located on the Flathead National Forest just outside the boundary to the northern edge of the Big Salmon Unit of the Bob Marshall Wilderness complex. It is approximately 40 miles north-northwest of the Scapegoat Wilderness portion of the complex. This is a high elevation, short season station situated at about 7,200 ft msl. Besides the Silver King Lookout (7,771 ft msl) this is the only other high elevation NFDRS station still providing weather and fire danger information for the Bob Marshall Wilderness complex. Data at this station has been collected every year during the 1973-1987 period.

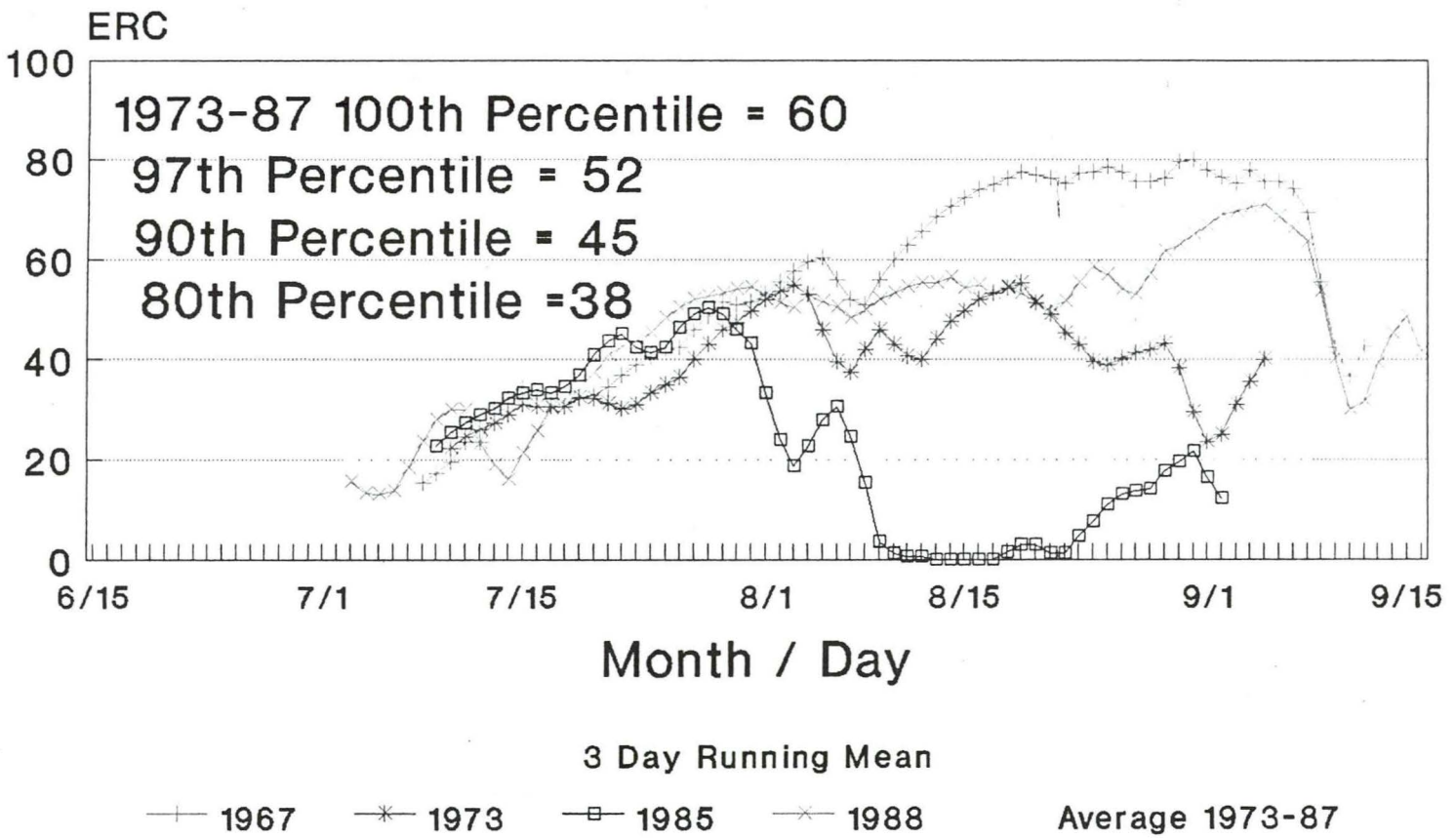
Section 4.1.4.1 Energy Release Component

The lookout on top of Spotted Bear Mountain begins to climb in seasonal average ERC levels on July 10th (14.5)(Figure 37). The increase in ERC levels are gradual, reaching a summer peak on August 6th (32.5). Following this early August peak the average ERC level undulates until reaching a late summer low value of 20.9 on September 1st. During the first ten day period of September the seasonal average ERC levels again begin to rise, attaining the maximum high ERC level of 33.8 on September 6th. This is the closest the seasonal average ERC values approach the 1973-1987 80th percentile level of 38. This station had the smallest variation in seasonal average ERC levels of the stations examined.

All four severe fire danger seasons documented for this station start to move above the seasonal average ERC level either immediately or shortly after that year's measurements are begun, between July 7th and July 10th. Only the 1988 ERC level rises and then falls briefly back to the average, all other seasons steadily continue their increase in ERC. On July 20, 1985 that season's ERC crossed the 80th percentile level, 1988 would be seen to do the same on July 21st. The 1967 season would wait until July 23rd to pass the 80th percentile, while 1973 would experience the longest delay crossing this demarcation line waiting until July 27th. All four seasons follow very similar trends in their ERC rise. The 1985 season was the first to reach a maximum ERC peak on July 22nd (45.00, 90th percentile level) and then began its season ending decline with the arrival of increasing humidity and finally rains. The remaining severe seasons also achieved the 90th percentile level within days of the 1985 season; 1988 on July 24th, 1967 on July 27th, and 1973 on July 29th, an interval of 8 days for all 4 seasons. Of these remaining severe seasons which continued to rise to the 97th percentile level (52.0), this boundary was reached at an even closer interval of 6 days; 1988 on July 27th, and both 1967 and 1973 on August 1st. The 1973 season would develop double maximum high ERC

Figure 37. Energy Release Component for the Spotted Bear Lookout NFDRS Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Energy Release Component
Spotted Bear Lookout (240213)



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level peaks on August 3rd (55.0), and then again on August 19th (55.3), before starting the season ending decline. Both the 1967 and 1988 seasons would continue there upward ERC movement until later seasonal peaks were attained. 1967 would experience very rapid increases in ERC levels after August 1st, and by August 14th ERC levels exceeded 70.0. These high 1967 levels above an ERC of 70.0 would be maintained for a continual 26 days, with a maximum high value reached on August 31st (80.0). The 1988 season never matched 1967 in ERC heights, but continued a steady climb upward until reaching the 1988 maximum high value of 71.0 on September 5th. A cold front passage on September 6, 1988 would prevent the ERC levels from increasing any further. Both the 1967 and 1988 seasons exceeded the 1973-1987 100th percentile levels of an ERC of 60.0.

Section 4.1.4.2 Burning Index

The seasonal average BI at the Spotted Bear Lookout, like the ERC index, shows a minimal amount of seasonal variability with a maximum average change of less than 21 points (Figure 38). While it is difficult to declare the seasonal average BI distribution bimodal because of the slight difference in summer values, there are two peaks achieved on August 6th (35.3) and again on August 28th (38.2).

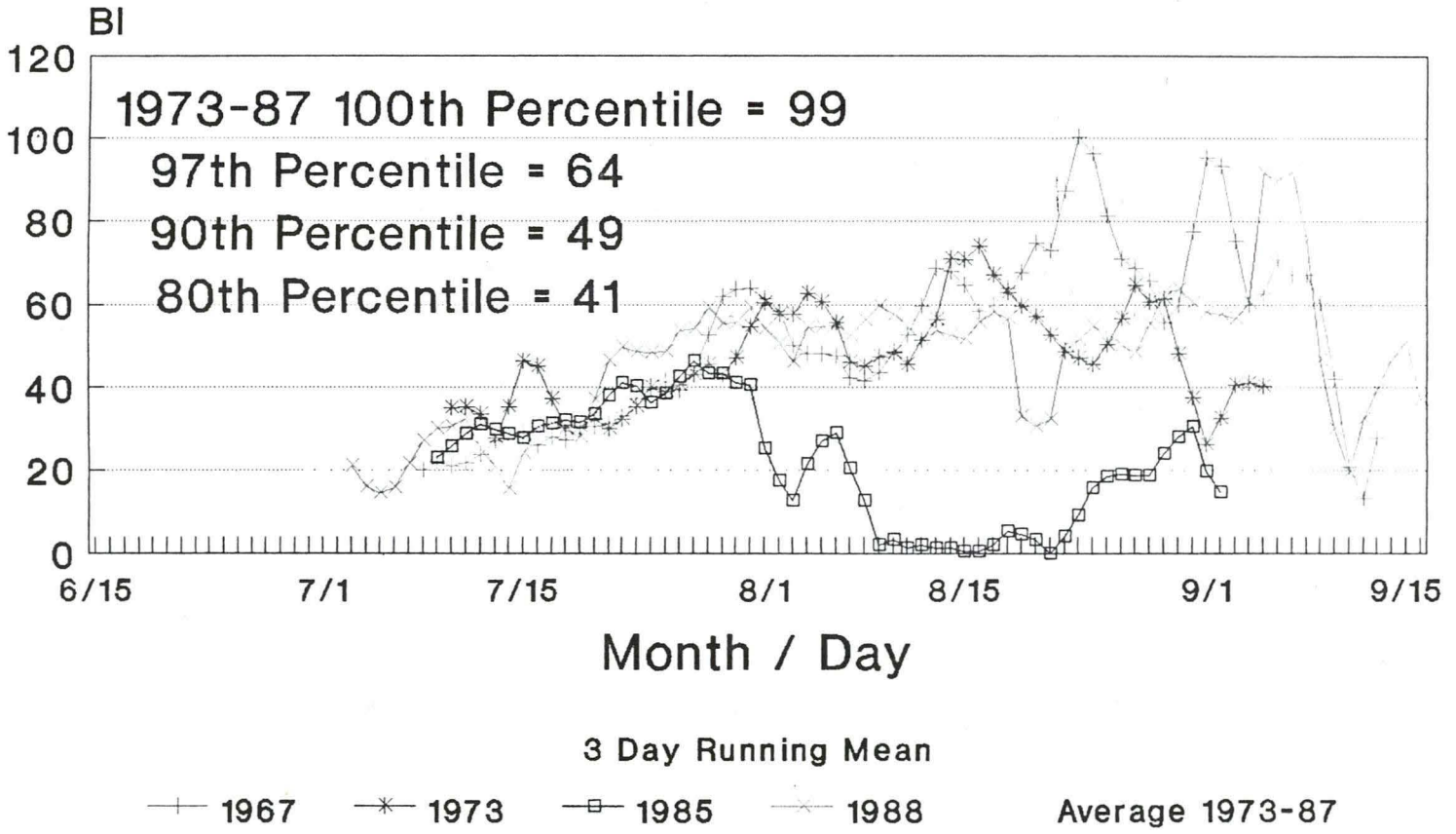
All 4 severe fire danger seasons can be seen to have cleanly climbed above the seasonal average BI values by July 16th. Each season steadily climbs away from the average BI, with the 1988 season initially showing a greater rate of deviation from the average. The 1967, 1973, and 1985 seasons from mid to late July are very similar in their BI levels. The 1988 season proved to be the earliest to move above the 80th percentile level (45.0) on July 21st (46.3). The 1988 season was followed in quick succession by 1985 on July 27th, 1967 on July 28th, and 1973 on July 30th. The 1985 season continued to climb until July 27th when a maximum high BI value of 46.3 was reached, after which the season ending decline commenced. The remaining three severe seasons continue to climb until late July - early August at which time each season tends to fluctuate around values between the 80th and 97th percentile (BI of 64) levels for the first ten day period of August. The 1967 and 1973 seasons rapidly climbed above the 97th percentile level by August 14th in 1973, and on August 18th in 1967. The maximum high BI value for 1973 would be attained on August 16th (74.0). The maximum high BI for the 1967 season would arrive on August 23rd (100.3), followed by a decline in BI then a rapid rebound to a second peak on September 1st (95.3) and the eventual season ending decline. The 1988 BI late season values and trends at this station is considerably different than what occurred during either the 1967 or 1973 seasons. Except for a short three day period when the 1988 BI dropped back to near average, the 1988 season stayed relatively level between BI values of 50 and 60. It would take increased winds on September 5-7 in 1988 to significantly change the BI level at the lookout. The 1988 maximum high BI value of 92.0 would be achieved on September 7th after which the BI plummeted back to seasonal average levels.

Section 4.1.4.3 Thousand Hour Fuel Moisture

Early July Thousand Hour Fuel Moisture values of 24% are the seasonal average maximum high values, and are followed by a steady decline (Figure 39). The seasonal average maximum low moisture level is reached on August 7th (17.1%) after a rate of decline in moisture of -0.3% per day. A slight rebound in moisture occurs following the maximum low until a small peak moisture value

Figure 38. Burning Index for the Spotted Bear Lookout NFDRS Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

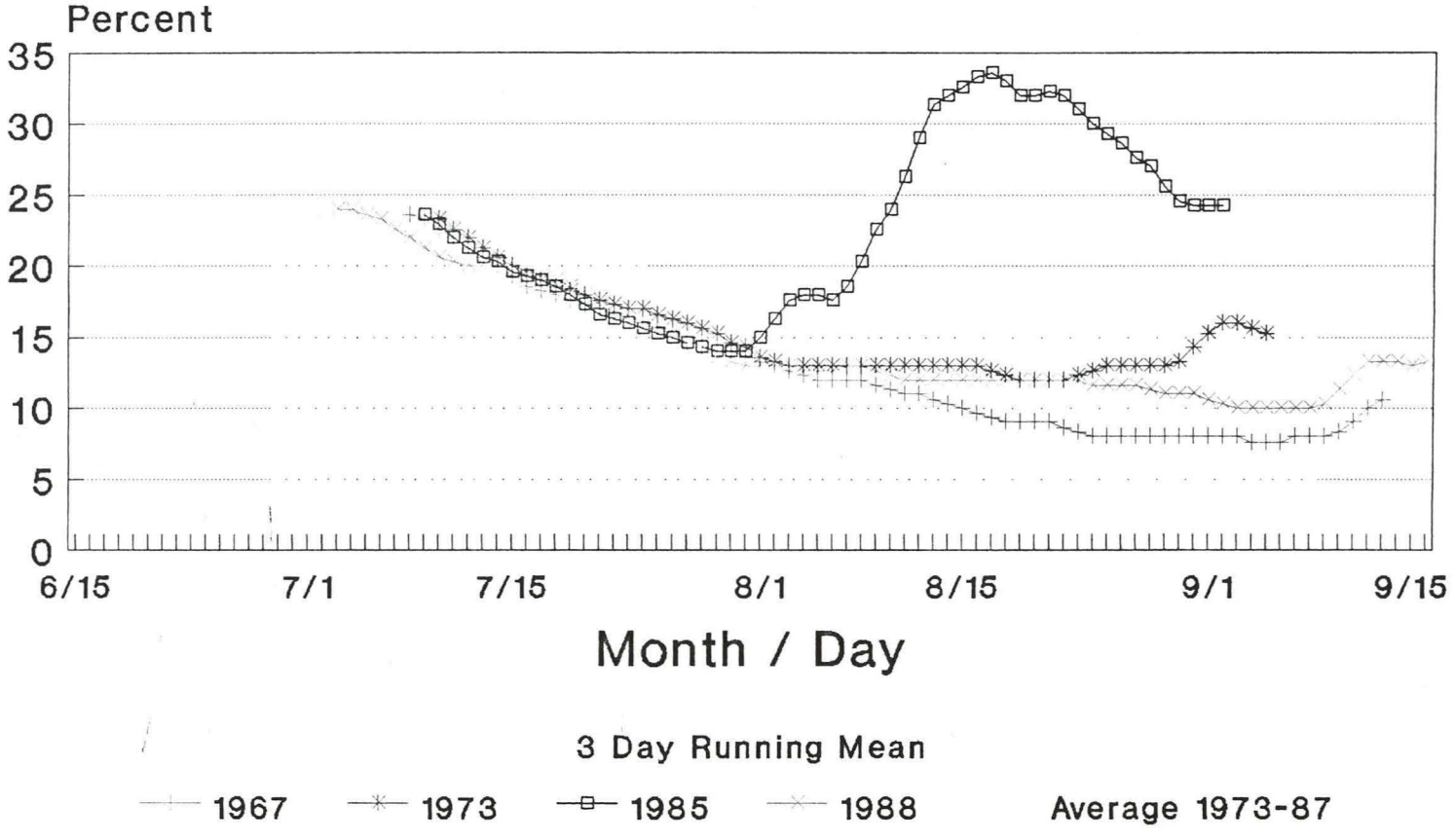
Burning Index
Spotted Bear Lookout (240213)



C. Bushey/MPFS

Figure 39. Thousand Hour Fuel Moisture for the Spotted Bear Lookout NFDRS Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Thousand Hour Moisture
Spotted Bear Lookout (240213)



C. Bushey/MPFS

is achieved on August 16th (18.7%) after which the moisture level remains relatively steady until declining slightly in early September.

While the 1988 severe fire danger season is the first of the four seasons documented to move below the seasonal average Thousand Hour Fuel Moisture level on July 7th, all began their decline below the seasonal average within four days of each other. All four seasons also had a very similar rate of moisture loss during the last half of July, approximately 0.2% per day. The 1985 season was the first fire season to reach the maximum low moisture content, 14% on July 29th. This level was maintained that season for 3 days before a rapid (+1.0% per day) return to the seasonal average occurred, followed by an even more rapid (+1.9% per day) climb well above normal for August. The remaining three severe seasons remained at the same approximate moisture levels until August 5th at which point the 1973 season stabilized at 13%. The 1967 and 1988 seasons would still continue to decline slightly with 1988 stabilizing at 12% on August 11th, and the 1967 season doing the same on August 18th at 9%. The 1988 season would reach a maximum low moisture content of 10% on September 3rd and maintained that level for 6 days before starting to recover. The 1967 season would reach a maximum low moisture content of 7.6% on September 4th and not begin recovery until after three days. These 7.6% readings were the lowest Thousand Hour Fuel Moisture readings for any of the severe fire seasons and stations documented. The 1967 season maintained 25 days with a moisture levels of 9% or less from mid-August until mid-September. This extended period of 9% or less moisture content was also the longest period of extreme drought measured from the stations. Both the 1967 and 1988 seasons started their moisture content recovery at approximately the same date, and much later than the other severe seasons evaluated.

Section 4.1.5 SPOTTED BEAR RANGER STATION, FLATHEAD NATIONAL FOREST

Spotted Bear Ranger Station is the low elevation companion NFDRS station to the Spotted Bear Lookout. This station is about 4 miles northwest of the lookout and is at an elevation of 3,725 ft msl, or 3,475 ft lower than the lookout. Spotted Bear Ranger Station is approximately 44 miles north-northwest of the Scapegoat Wilderness portion of the Bob Marshall Wilderness complex. No missing years of data between 1973-1987 occur at this station.

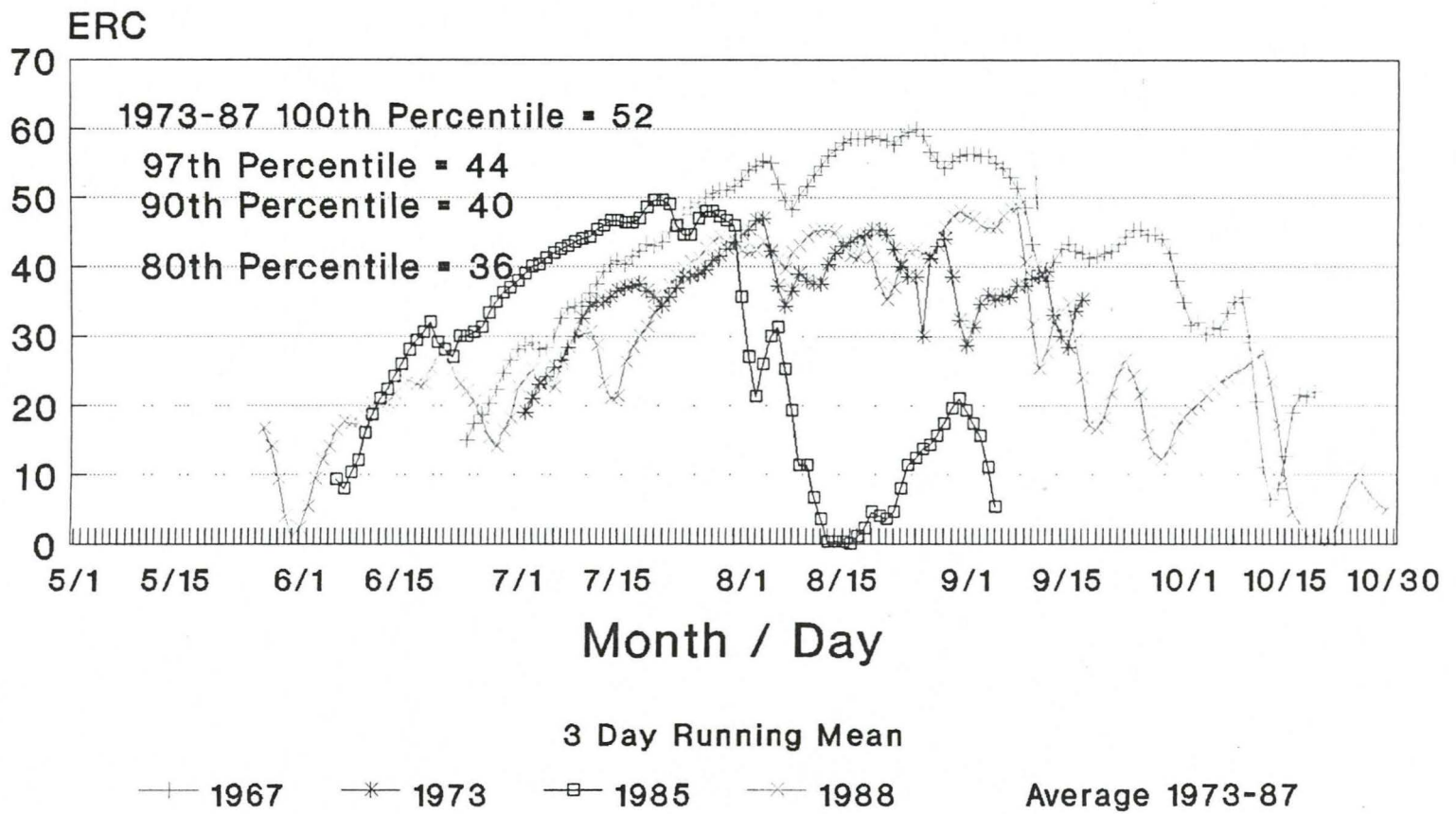
Section 4.1.5.1 Energy Release Component

The seasonal average ERC begins the season with a maximum low ERC value of 4.3 on May 30th (Figure 40). From this point in time the ERC level at this station climbs rapidly at first, then more gradually in July until achieving the first peak of a bimodal peak distribution. This first peak occurs on August 1st (32.0), followed by an undulating decline into late September. The second peak is found during the first half of October and occurs after a rapid rise to 26.8 on October 9th. The 80th percentile calculated from the 1973-1987 seasonal data is 36, while 40 marks the 90th percentile level.

Both the 1985 and 1988 severe fire danger seasons initially climbed above the seasonal average by June 11th. However, while the 1985 season would continue to rapidly climb above the seasonal average the 1988 season tumbled back below the average for an extended period of time. 1985 would pass the 80th percentile level on June 29 (36.3). The next season to move above the seasonal average was 1967 which occurred on June 30th, and which continued climbing in a steady manner. July 5th would be the date the 1973 season moved

Figure 40. Energy Release Component for the Spotted Bear Ranger Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Energy Release Component
Spotted Bear Ranger Station (240214)



C. Bushey/MPFS

above the seasonal average and also continued to move upward at a steady rate. It wouldn't be until July 17th that the 1988 season at this station would finally recover enough to again sustain a climb above the 1973-1987 average ERC level. The 1985 season would reach the season's maximum high ERC value on July 20-21 (49.6) before beginning to collapse under persistent rains. No other severe season examined achieved the 80 through 97th percentile levels (June 29 and July 10) as rapidly as the 1985 season. It would take until July 11th (36.3) for 1967, July 15th (36.6) for 1973, and July 21st (36.0) for 1988 to attain the 80th percentile level. The 1973 season would reach it's maximum high ERC on August 4th (47.0), and while the season stayed at ERC levels generally above the 80th percentile through early September it never again surpassed the August 4th value. A steady climb to heights above the 1973-1987 100th percentile level marked the 1967 season. This season reached its maximum high ERC on August 25th (60.0), dropped slightly for another 10 days, then started to decline to the 90th percentile on September 5th. Between September 13th and 29th the ERC level stayed between the 90th and 100th percentile levels, then began it's season ending decline. 1967 would record 47 days at or above the 97th percentile level of the 1973-1987 seasons, and 31 days above the 100th percentile for this station. The late-summer 1988 season seldom approached 1967 in ERC fire danger severity. While the 1967 season was at ERC levels above the 100th percentile, the 1988 ERC index values were consistently between the 90th and 100th percentiles. A maximum high 1988 ERC level of 48.6 would be achieved on September 8th, followed by a precipitous decline. There would be 16 days during 1988 that would equal or exceed the 97th percentile, none over the 100th percentile level. By September 11th the 1988 season had returned to the seasonal average ERC levels and except for a brief period would remain below that level. It would take the 1967 season until October 11th before the ERC level dropped back below the seasonal average.

Section 4.1.5.2 Burning Index

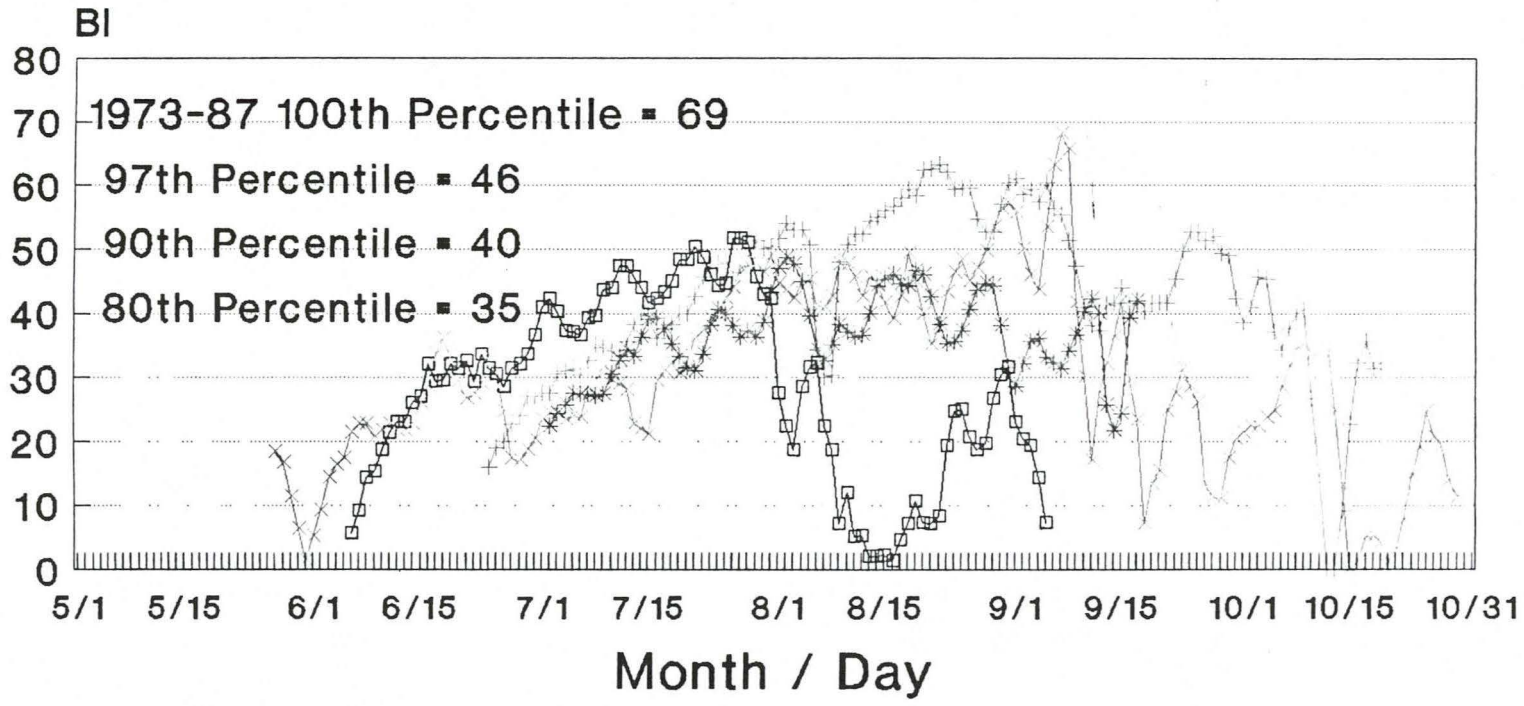
The seasonal average BI at the Spotted Bear Ranger Station reaches a maximum low on May 21st (Figure 41). A summer seasonal average peak is reached on August 1st (31.8) after a steady two month climb. Following the summer BI peak there is a similar two month decline in BI with occasional small peaks around the last ten day period of August, and during the second and third ten day periods of September. beginning at the end of September there is a rapid increase in BI measured fire danger which reaches a late season peak of 33.5 on October 4th. The 80th percentile level for BI at this station from the 1973-1987 years was 35, while the 90th percentile level rose to 40.

The overall pattern of the development of the individual severe fire danger years as measured by BI is very similar to the previously discussed pattern for ERC. The BI usually took from one to two extra days to climb above the seasonal average than did the ERC values. 1988 was the earliest of the four seasons to reach the 80th percentile with a brief rise to 36.0 on June 18th. The 1985 season during this early seasonal period very closely matches the rise of 1988. 1985 would not attain the 80th percentile level until June 30th (36.6) and after this point in time would climb faster than the 1988 season which fell back to below the seasonal average. 1985 would pass the 90th percentile level on July 1st (41.0), and the 97th percentile on July 11th (47.3). Maximum high BI levels of 51.6 would be reached on July 26-27, 1985, followed shortly by the season's dramatic collapse. It would take 1967 until July 22 (45.6) to reach the 90th percentile, and only the next day to achieve the 97th (47.3). After recovering from the late June tumble back below the

Figure 41. Burning Index for the Spotted Bear Ranger Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Burning Index

Spotted Bear Ranger Station (240214)



C. Bushey/MPFS

seasonal average, the 1988 season regained its momentum and again gained the 80th percentile level on July 21st (36.0) and rapidly rose to the 90th on July 25th (42.3), and then the 97th on July 27th (47.0). The 1988 season would fluctuate mostly between the 90th to slightly above the 97th percentile levels until late August. The 1973 season after an undulating climb finally reached the 90th percentile on July 31st (43.3), and after a brief period back below the 80th percentile level would finally climb up to the 97th percentile on August 1st (47.0). The next day would see the 1973 maximum high BI level reached (48.6). After attaining this level the 1973 season would fluctuate between the 80th percentile to just below the 97th percentile until September 12th. A maximum high BI would be set on August 22nd in 1967 (63.3). The 1967 season would eventually have 46 days above the 97th percentile level; most of late July, all of August, and early September. A maximum high BI would finally be reached during 1988 on September 7th (68.0), just below the 100th percentile level. 1988 BI levels would begin to drop on September 8th, and would end up with 21 days above the 97th percentile level. Only the 1967 and 1988 seasons of the four examined continued with average to above average BI values into late September and October. Of the two seasons, 1967 had the greatest fire danger rating at this station, staying above the 80th percentile level until October 6th.

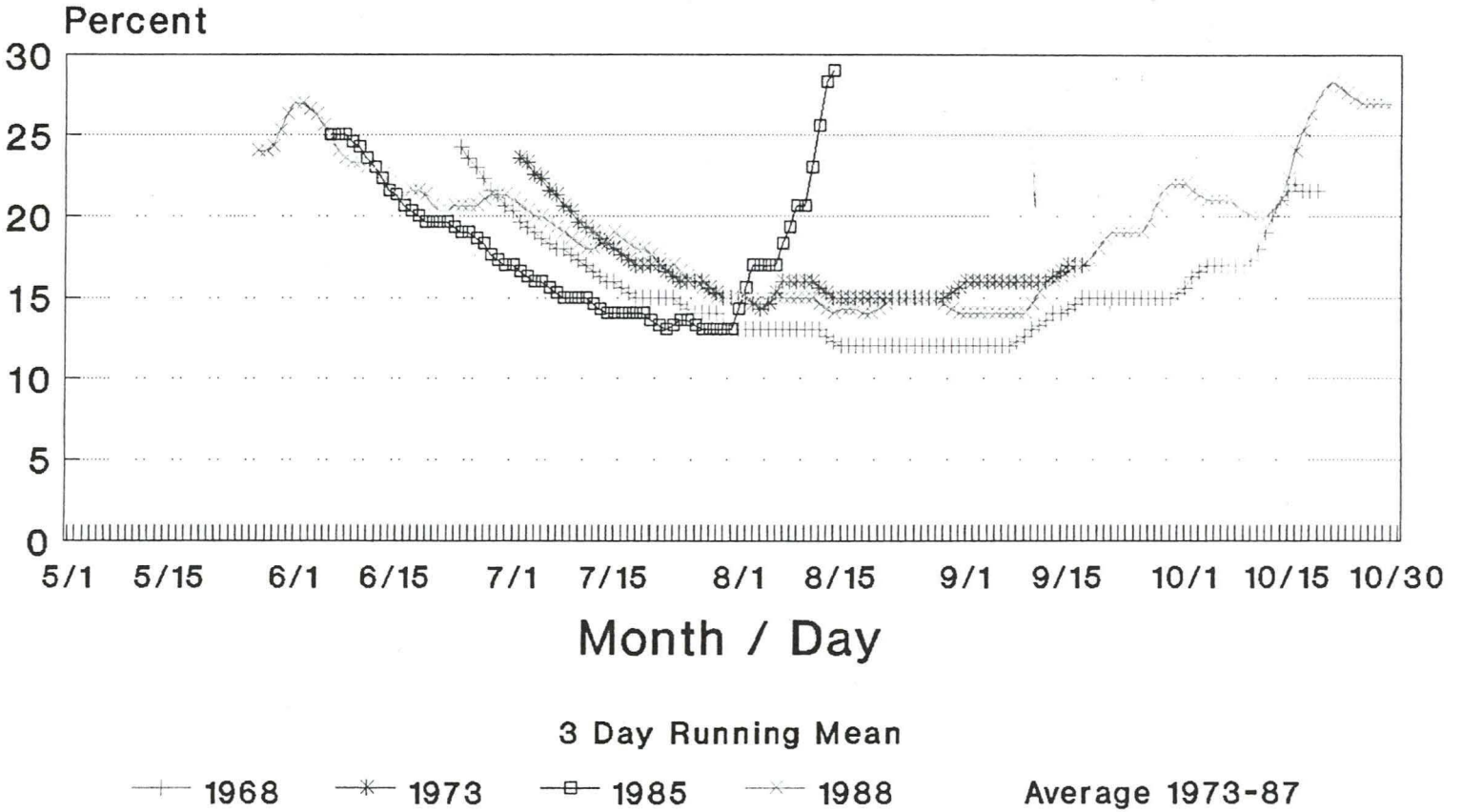
Section 4.1.5.3 Thousand Hour Fuel Moisture

The high seasonal average Thousand Hour Fuel Moisture occurs on May 31st (25.7%) before entering into the fire season period of declining moisture (Figure 42). A decline (-0.2% per day) in moisture occurs until June 29th, after which there is approximately half of a month of a slight increase in moisture content. A gradual decline (-0.1%) of moisture continues until a seasonal average maximum low value of 17.4% is attained on August 2nd. After this low value there is an increase in moisture (+0.3% per day) until the later part of August when a plateau is reached of about 18.9%. beginning on August 31st moisture levels again increase (+0.2% per day) until an end of the season maximum high moisture level of 21.9% is reached on September 12th. These high moisture levels are maintained until October at which time a period of drying evidently occurs, again lowering the moisture content temporarily before the arrival of snow.

Of the four severe fire danger seasons investigated the 1985 season at this station was the first to start to move below the season average Thousand Hour Fuel Moisture level (June 17th, 20.3%). The 1988 early season moisture levels ranged slightly above the seasonal average, both the 1967 and 1973 seasons declined from levels much higher than the average. 1967 would move below the average on July 3rd (19.3%) at an initial steep decline (-0.4% per day). The 1988 season is the next in chronological order to move below the average on July 6th (19.6%) and dropped at an approximate rate of -0.2% per day. The 1973 season waited until July 11th (19.3%) before the seasonal average boundary was crossed, with Thousand Hour Fuel Moisture levels dropping at a rate also about -0.2% per day. After declining at rates similar to the 1973 and 1988 seasons, the 1985 season reached a maximum low moisture level of 13% on July 22nd. There would be a total of six days at this level during 1985 before levels again began to rebound on August 1st at a rapid rate of +1.1% per day. In 1973 the maximum low moisture content would be briefly attained on August 4th (14.3%) and then after a brief fluctuation the level would stabilize at 15.0% for the last half of August. During the 1967 season the maximum low moisture level was reached on August 12th at 12%, and was maintained at that same level

Figure 42. Thousand Hour Fuel Moisture for the Spotted Bear Ranger Station, Flathead National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Thousand Hour Moisture
Spotted Bear Ranger Station (240214)



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for 24 days. The 1967 season recovered slowly at a rate of about +0.2% per day. 1988 would experience three periods when the maximum low moisture content of 14.0% was reached. The first period in 1988 began on August 14th for the single day, again on August 18th for two days, and the last period began on August 31st and lasted for ten days through September 9th. Moisture recovery in 1988 occurred at a rate of +0.3% per day.

Section 4.2.0 East Side Fire Danger and Comparisons with 1988

Section 4.2.1 GLEASON'S RESORT NFDRS STATION

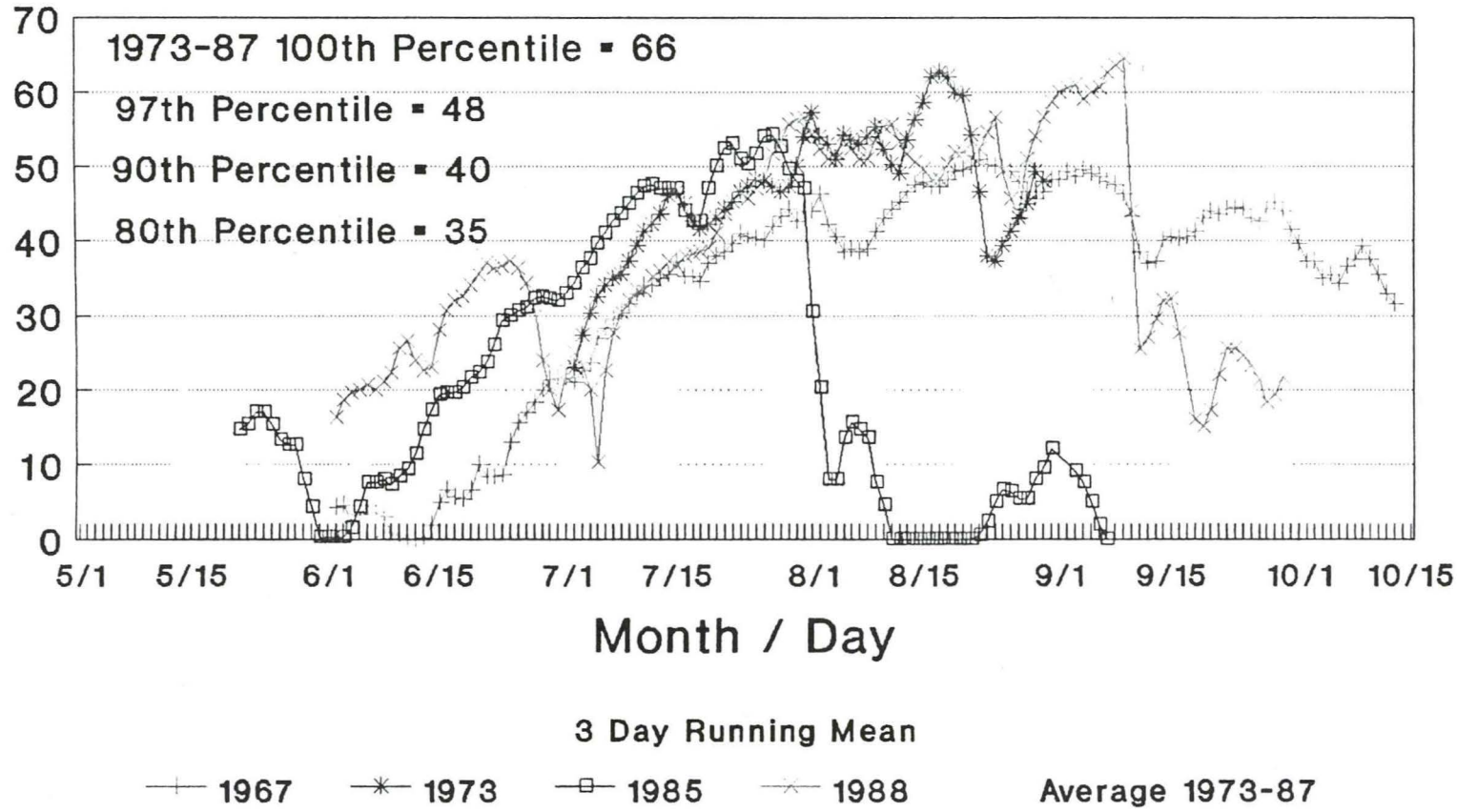
Section 4.2.1.1 Energy Release Component

The 1973-1987 fifteen year record at the Gleason's Resort NFDRS Station near the Lewis and Clark National Forest has a seasonal average maximum low ERC reading of 6.2 on June 8th (Figure 43). As the seasonal average ERC level rises several minor peak ERC levels are reached often enough to be outstanding features in the averaged data. These occur on June 14th (19.5), and again on June 24th (24.2). The seasonal average maximum high ERC level is reached on July 29th (29.3) before a gradual decline in fire danger occurs. The 80th percentile ERC level for the 1973-1987 years was determined to be 35, while the 90th percentile climbed to 40.

The 1988 severe fire danger season started much higher at this station than did the other severe seasons evaluated. That early 1988 season would briefly climb above the 80th percentile level for 6 days beginning on June 20th (35.6), then rapidly drop back to below the seasonal average before again attaining such percentile heights. It took until June 16th for the 1985 season to move above the seasonal average with a reading of 19.6. 1985 then climbed almost continually until reaching a maximum high ERC level of 54.3 on July 27th and was the first of the four consecutive severe seasons to achieve the 80th through 97th percentile levels before the season ended abruptly. The remaining four seasons moved above the seasonal average for the rest of their fire season measurements during a six day period beginning in early July (July 2, 1973 at 23.3; July 4, 1967 at 23.6; and July 7, 1988 at 27.6). All four seasons continually gained in ERC levels and except for 1967 exceeded the 97th percentile level by the end of July. Starting about August 1st each of these remaining severe seasons experience varying degrees of ERC decline after which is a period of stabilization. About August 15th the ERC levels have either already started to rebound are will start to do so within a few days. The 1973 season was the next chronological maximum high ERC level reached, 62.6 on August 17th. 1967 maximum high ERC level would never attain the height at this station as the 1973 and 1988 seasons did, 51.0 on August 23rd. 1988 would prove to be the longest sustained severe season, not reaching the maximum high ERC until September 9th (64.5). Both the 1973 and 1988 seasons encountered season ending events which caused sharp ERC declines. The 1967 season gradually declined, still remaining above the 80th percentile level as late as October 3rd.

Figure 43. Energy Release Component for the Gleason's Resort NFDRS Station, near the Lewis and Clark National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Energy Release Component
Gleason Resort (241802)



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Section 4.2.1.2 Burning Index

The 15 year (1973-1987) seasonal average for the Gleason's Resort NFDRS Station begins from a low BI (11.4) on June 5th and begins to rise into a multi-peaked season (Figure 44). No other station examined has as much variability throughout the season which has created BI peaks and valleys. As noted with the minor peaks which occur with the seasonal average ERC, these peaks evidently occur with sufficient regularity at specific times of the season to be prominent features of the averaged index. As the average season gains in BI, peaks are noted on June 13-15 (25.5), June 23rd (31.4), July 22 (32.8), and August 1st (33.9). A declining average BI occurs through the first half of August, then rebounds reaching new peaks on September 3rd (31.6), and September 9th (30.3). Again after a short period of declining BI values a late seasonal average maximum high BI value of 35.4 is reached on September 23rd. The calculated 80th percentile level from the 15 years is 41, and the 90th percentile reaches 48.

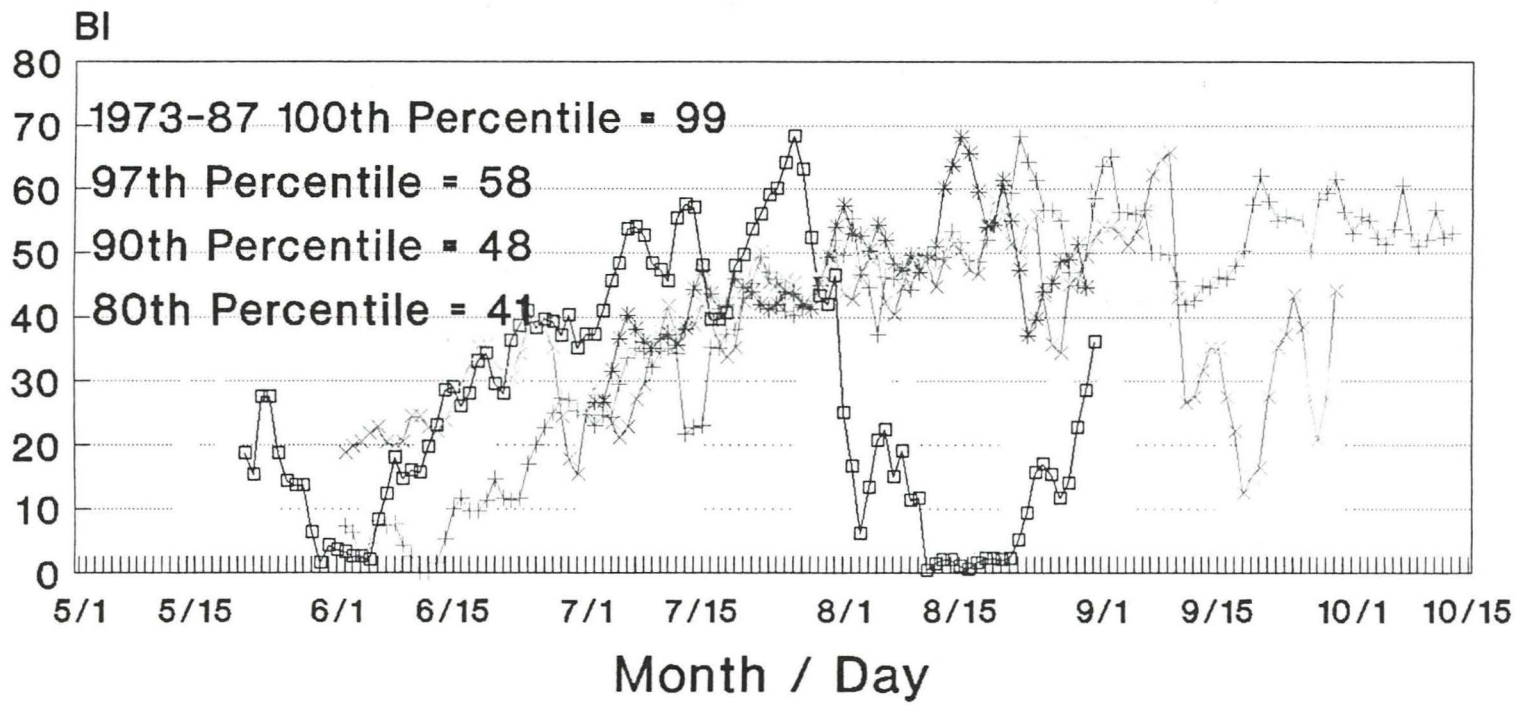
Both the 1985 and 1988 seasons started similarly with a climb above the seasonal average beginning about June 15th. 1985 would continue the early season climb reaching the 80th percentile level by June 24th (41.0), and the 90th shortly after July 5th (48.3). A maximum high BI peak for 1985 would be reached on July 26th (68.3), well above the 97th percentile level. The BI levels for 1988 at this station would fall back to below the seasonal average and not begin to move above that average again until July 9th (35.6). Both the 1967 and 1973 seasons had moved above the seasonal average by this date, but it did not take the 1988 season long to match those seasons in BI and all three years followed very similar trends in rising BI. The 80th, 90th, and 97th percentile levels were reached during 1967, 1973, and 1988 at very close intervals. The 80th percentile for the different seasons were attained within 6 days of each other; July 14, 1973 (44.3), July 20, 1967 (43.0), and July 20, 1988 (42.3). The 90th percentile BI was reached within 9 days during the different years, and very shortly after the 80th level; July 21, 1988 (48.3), July 22, 1967 (49.3), and July 30, 1973 (49.3). All 3 years reached the 97th percentile level again at close intervals within a 7 day period; August 13, 1973 (60.0), August 19, 1988 (58.0), and the latest was on August 20, 1967 (60.6). The 1967 and 1973 seasons very quickly moved to attain what would be their maximum high BI for those seasons of 68.3 on August 22nd, and 68.0 on August 15th, respectively. The 1988 season would not reach it's maximum high BI level until September 9th (65.5). Following these peaks the 1967 season stayed mostly above the 90th percentile the remainder of the season, 1973 would remain above the 80th level before the readings were abruptly ceased, and the 1988 season returned to near average levels only breaking above the 80th percentile on two days.

Section 4.2.1.3 Thousand Hour Fuel Moisture

The maximum high Thousand Hour Fuel Moisture value from the seasonal average occurs on May 31st (29.2%)(Figure 45). After another short period of relatively high moisture content around June 8th (28.3%), the Thousand Hour Fuel begins a continuing period of seasonal drying (at a rate of about -0.2% per day). A seasonal average maximum low moisture content of 19.0% is reached on August 2nd. Much of the last half of August experiences a slight rising in fuel moisture contents (+2.5% per day), and then a decline again into early September (-0.3% per day). Starting on September 8th seasonal average Thousand Hour Fuel Moisture levels are generally on the increase (+0.9% per day).

Figure 43. Burning Index for the Gleason's Resort NFDRS Station, near the Lewis and Clark National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

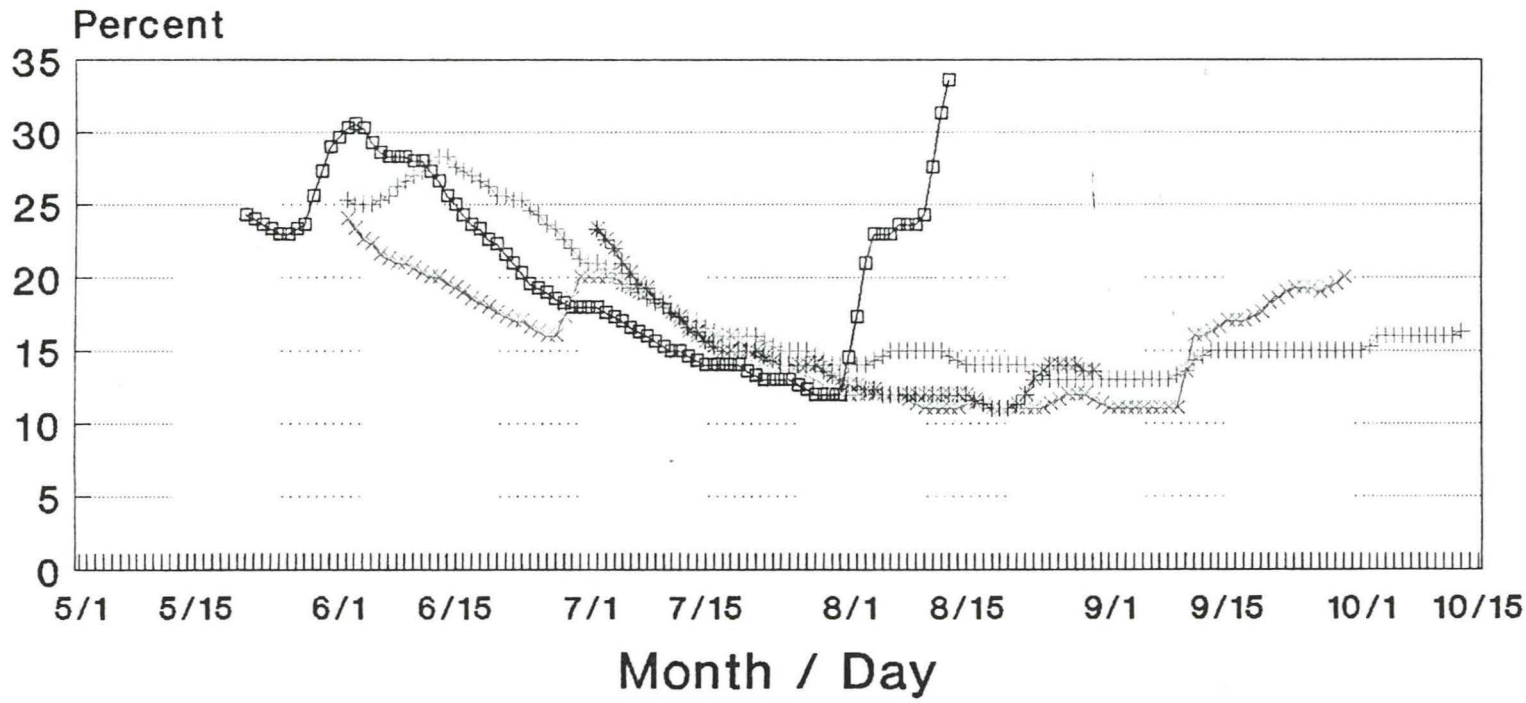
Burning Index
Gleason Resort (241802)



C. Bushey/MPFS

Figure 45. Thousand Hour Fuel Moisture for the Gleason's Resort NFDRS Station, near the Lewis and Clark National Forest; Seasonal Average 1973-1987, 1967, 1973, 1985, and 1988 severe fire danger seasons.

Thousand Hour Moisture
Gleason Resort (241802)



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Thousand Hour Fuel Moisture content in 1985 started slightly below normal but quickly moved back to above average during the period when the seasonal maximum high value typically occurs. Moisture values during that season would follow the seasonal average until mid-June then again drop below. Both the 1967 and 1988 seasons also began with their initial measurements below the average during the early portion of the seasons. 1967 would gain moisture until mid-June before again beginning to decline. The 1988 season differs from these other seasons because in did not gain moisture during the typically moist late May - early June period. An early season rapid (-0.3% per day) decline in moisture continued until late June at which time some moisture was received. The late June moisture is not evident from the 1967 and 1985 seasons both of which had again passed below average by this time and were starting their decline (1967, a rate of -0.2% per day; 1985, a rate of -0.3% per day) in to their respective fire seasons. 1988 again began to decline on July 5th (19.6%) at a rate of about -0.3% per day until reaching a maximum low moisture of 11.0% on August 18th. There would be twenty-one days during the 1988 season of moisture at the 11.0% level. Eleven percent Thousand Hour Fuel Moisture is the lowest moisture content level achieved by any of the severe fire danger seasons evaluated at this station. Only the 1973 season equaled this low level but for a relatively brief period of only 3 days. The 1985 season reached it's maximum low moisture level on July 28th (12.0%) and would remain at that level for 3 days before rising moisture levels indicate the beginning of the end of the season. The 1973 season, as noted above, reached its low level of 11% on August 18th after a decline rate of approximately -0.3% per day. 1967 would only achieve a maximum low moisture of 13.0% achieved on August 25th and which would be maintained for a period of fifteen days. Both the 1967 and 1988 seasons would remain below the seasonal average in to late September.

Section 5.0.0 Canyon Creek Fire; Fire Behavior, Fire Weather, and Fuel Moisture Chronology

This chronology of the Canyon Creek Fire has been developed from interviews with available individuals who were involved during critical periods of the fire, as well as from radio logs from the different Forest Service offices surrounding the fire. The radio logs in particular proved to be an important information source, especially in providing times and locations for particular fire events. Whenever possible, events documented have been cross referenced through interviews with participants, and reviews of more than one radio log. The purpose of this chronology is to document fire behavior and contributing environmental influences to the fire behavior. When more than one reference source provided a time or information on an event, usually only the reference closest to the event or which provided the most information was used. Frequently though, radio logs from surrounding offices might contain different information and when this was considered important the transmission was included. At times it is difficult to reference particular fire behavior events, especially during some of the later stages of the fire, without also referring to the suppression actions which were also taking place. However, it is not the purpose of this documentation to cover the various fire containment and suppression actions.

RAWS (Remote Automatic Weather Station) fire weather and fuel moisture measurements were collected from stations located on Monture Creek (Seeley Lake Ranger District, Lolo National Forest), and near Benchmark (Rocky Mountain District, Lewis and Clark National Forest). Also, during the severe, wind driven crown fire event of September 6-7, 1988 RAWS data is presented from a high elevation station located at Spotted Bear Lookout (Spotted Bear Ranger District, Flathead National Forest). Data from the RAWS units included air temperature, relative humidity, average 20 ft wind speed, maximum 20 ft wind gust (1 hour period), and 1 and 10 Hour Experimental (calculated) Fuel Moisture. Manually collected data from the Silver King Lookout on the Helena National Forest is also presented and in most cases included air temperature, relative humidity, and average wind speed and direction. Fuel moisture and weather data from these individual stations are graphically presented in 5 day increments. RAWS data is generally collected hourly at specified Mountain Standard Times (MST). When presented graphically the RAWS data time is MST. This time is converted to Mountain Daylight Time (MDT) within the text to correspond with the times given by radio logs and the occurrence of events as timed by individuals during the fire.

The Monture RAWS is located on a south facing slope (4,285 ft msl) approximately 8.5 miles west of the Scapegoat Wilderness, and near the junctions of the Monture and Dunham drainages (T16N, R12W, Section 19). This station would eventually be nearly an equal distance from the Canyon Creek Fire. Data from this station is very intermittent during the early portions of the 1988 fire season, but improves as the season progresses. Wind speed data was not available until September. However there is a good record for the September 6-7 fire event. The time period from July 18 until September 15th from the Monture RAWS is documented in this report.

The Benchmark RAWS is placed on a flat bench overlooking Wood Creek (5,350 ft msl) approximately 1 mile east of the Half Moon Unit of the Scapegoat Wilderness boundary and about 12 miles north of a portion of the Canyon Creek Fire. Data from the Benchmark RAWS is first picked up in this report on July 24th and is continued until September 15th. Except for occasional periods of

data lost, this station consistently provided good information. Maximum wind gust information was not collected until August 9th.

Using the two RAWS stations as a base, the 1 Hr Fuel Moisture was calculated at various elevations on the fire using the Moisture Module in the BEHAVE Fire Behavior Prediction Program (Andrews and Chase, 1989). The Moisture Module corrects for changes in elevation and solar heating. The module does not account for complex moisture situations as may be induced by subsidence inversions at higher elevations than the monitoring station. These within fire moisture values are referenced by the side of the Continental Divide they were calculated for and the base monitoring station used to formulate the values; Monture Raws for the West Zone, and starting on August 9th when the Canyon Creek Fire first burned over the Continental Divide the Benchmark RAWS for the East Zone.

NFDRS 10 Hr and 1000 Hr fuel moisture calculations (3-day running mean) from stations located at the Lincoln and Seeley Lake Ranger Stations are presented daily for the area west of the Continental Divide. The closest east side station to monitor these same conditions was the Gleason's Resort Station, and is included daily after the fire crossed the Continental Divide on August 9th.

Daily fire perimeter growth for the Canyon Creek Fire was initially started by the Fire Behavior Analysts (FBA's) who were responsible for monitoring the fire at different intervals. The map these individuals created in most instances very closely matched burn patterns evident from aerial photographs for individual fire days. The fire perimeter growth map presented in Volume 1 of "The Canyon Creek Fire Documentation" (fold-out pocket map, scale 1:100,000) incorporates data from the map drawn by the FBA's, interpretation of fire growth based on the aerial photography and changing fire severity patterns. Later stages of the fire also included infrared aerial photography, as well as information from interviews with personnel on the ground at the time. The FBA's fire perimeter growth map followed the fire through August 30th. Perimeter growth essentially ceased on September 7th with mostly interior burning continuing after that date. Other fire perimeter maps of the Canyon Creek Fire that covered this September period and were completed either during the fire or shortly thereafter show additional growth through September 9th. There was a significant increase in fire activity on September 9th east of the Continental Divide in the Falls Creek and Josylin Basin areas that resulted in newly burned acreage. Most additional acreage on the earlier maps is due to increased accuracy in perimeter mapping for September 7th and not increased perimeter burning after that date.

The fire growth progression map which is presented in Volume 1 (fold-out pocket map) also illustrates the topographic features of the landscape which provides an improved sense of how the topography and fire behavior interacted.

JUNE 25 (Julian Date 177)

Fire was ignited by lightning during the evening near the intersection of Canyon Creek and the Dry Fork of the Blackfoot River. An hour long driving rain followed the strike. The rain extinguished the flames, but the fire continued to smolder. Burning debris had been scattered across an area 1/3 acre in size when the strike had hit a Douglas fir tree. Campers who had witnessed the strike gathered burning debris and threw then toward the center of the fire to slow its spread. A fire line was built across the top of the fire to prevent it from threatening their camp (USDA Northern Region, 1989).

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 40.6
Actual ERC for the day: 48

Seeley Lake Ranger Station; 3-day running mean ERC: 33.6
Actual ERC for the day: 35

Within the Fire Management Plan the pre-season (prior to June 30th) ERC 80th percentile level of 33 recommends the decision point between Complexity Level I and Complexity Level II prescribed fire decision processes for natural ignitions within the Blackfoot Unit of the Scapegoat Wilderness. This ERC level is flexible based on the experience with early season fire behavior in the wilderness. A Team Fire Impact Analysis is required of all Complexity Level II fires (USDA, 1981). A Level I Analysis would later be started on this ignition giving temporary approval of the fire as a prescribed natural start. The Fire Management Plan dictates that the Lincoln Ranger Station weather station data be used for determination of Fire Danger Ratings for the Blackfoot Unit where the ignition had taken place.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 12.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 14.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 17.0%

Regional Weather: A few morning thunderstorms occurred during the morning in the extreme southeast corner of the Region as subtropical moisture from the southern California coast was brought northward over southeastern Oregon and southwest Idaho. Overnight low temperatures were mostly in the 50's and 60's, ranging from 45 in Libby to 68 in Miles City. During the afternoon skies were mostly clear and sunny with easterly winds from a southern Saskatchwan surface high pressure system. Wind gusts reached 35 to 40 MPH at Havre and Lewistown. Scattered thunderstorms were developing in the southwest and southcentral portions of Montana. The hot temperatures for the past month were being attributed to a nearly stationary high pressure system aloft over Wyoming which continued to bring above normal temperatures on this date. Temperatures were in the mid-80's to mid-90's in the west and 90 to 100 east of the divide, ranging from 83 at Mullan, Idaho to 101 in Billings. Heavy thunderstorms developed over western Montana during the night causing some damage from the strong winds, lightning was also a problem. Both were factors in knocking out power in the area (Bushey, 1989).

Miscellaneous: Areas of severe and moderate soil moisture continued to be reduced by the expanding area of extreme drought as indicated by the Palmer Drought Severity Index. Extreme drought conditions extended from the western edge of Montana east across the northern states into central Wisconsin; south into northern Utah, northwestern Colorado, and northern south Dakota. Within the Region only the northern Idaho panhandle remained moist (Bushey, 1989).

JUNE 26 (Julian Date 178)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 39.0
Actual ERC for the day: no data
Seeley Lake Ranger Station; 3-day running mean ERC: 33.3
Actual ERC for the day: 28

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 13.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 15.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.6%

Fire Behavior: It rained throughout the night, but smoke was still visible in the morning (USDA Northern Region, 1989). The report for this date from the Seeley Lake Ranger Station indicated that as of 1400 hrs there had been 0.16" of 24 hr precipitation. No report was filed from the Lincoln Ranger Station. Fire was first reported by Smoke Elser through the Forest Service Wilderness Guard Kathey Heffernen (Bailey and others, 1988). A Complexity Level I Analysis was initiated as required by the Scapegoat/Danaher Fire Management Plan (USDA Northern Region, 1989).

0955 hrs. "As of 0940 there is a fire in the Scapegoat, Canyon Creek. BL told folks not to put it out. Seeley Station .15" rain." (Lolo National Forest, Fire Dispatch radio log.)

Regional Weather: Thunderstorm activity continued on through the night over western Montana and rainshowers were heavy over northern Idaho. Temperatures during the night were in the 60's and 70's at most stations, and ranged from 60 at West Yellowstone to 76 at Miles City at 0600 hrs. Skies became mostly cloudy in the west and partly cloudy elsewhere during the afternoon. Continued thunderstorm activity was occurring in the southwest quarter of Montana with Helena getting a heavy rainfall and a 20 minute hail and rain storm at Stanford. Afternoon temperatures were again hot with 70's west of the divide and 95 and up east of the divide. For the 15th day this month Billings set or equalled the high temperature mark for the date, today with 102 degrees. 108 at Glasgow was also another record and was the regional high temperature for the date. The 108 degree reading was only 2 degrees below the national high temperature reading from Phoenix, Arizona. Livingston had the strongest afternoon winds gusting to 39 MPH out of the southwest. A Red Flag Warning was issued by the National Weather Service for dry lightning during the night across the southern Montana mountains as the trailing edge of Pacific weather front pulled upper level moisture from Idaho and Oregon. Afternoon convective heating would trigger the thunderstorms (Bushey, 1989).

JUNE 27 (Julian Date 179)

Complexity Level I Analysis completed (USDA Northern Region, 1989).

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 36.3
Actual ERC for the day: no data
Seeley Lake Ranger Station; 3-day running mean ERC: 30.3
Actual ERC for the day: 33

Weather conditions from the Seeley Lake Ranger Station are used to document current conditions for the development of the Wilderness Fire Situation Report. This document is included in the Incident Plan developed on this date to support the natural ignition prescription decision process. Data from the Lincoln Ranger Station was again not included in the NFDRS for this date. Seeley Lake Ranger Station recorded a trace of precipitation for the 24 hrs.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 15.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 18.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.6%

Fire Weather: Cloudy (USDA-Northern Region, 1989).

Regional Weather: The National Weather Service Red Flag Warning was continued throughout the day and into the evening for the threat of dry lightning in western Montana and northern Idaho as a weakening Pacific weather system was expected to push across that area. Thunderstorms moved across western Montana during the morning, some with brief heavy rainshowers. Thompson Falls reported .25" hail that covered the ground. These storms were associated with a Pacific weather system. A thunderstorm also traveled across the Billings area dropping .23" of rain. Morning low temperatures were mostly in the 50's and 60's, ranging from 52 at Butte and Dillon to 73 at Broadus. Scattered thunderstorms continued into the afternoon, one heavy storm hit Kalispell with wind gusts to 55 MPH. These storms brought rain to the western and central portions of Montana with most locations receiving under .25". East of the divide skies were mostly sunny with only isolated thunderstorms. Afternoon temperatures ranged from 70's in the west to the upper 80's and 90's in the east. Drummond was the coolest location during the afternoon with 74 degrees, Baker was the warmest with 99. Thunderstorms continued into the evening (Bushey, 1989).

JUNE 28 (Julian Date 180)

Canyon Creek fire was temporarily declared a prescribed fire based on a preliminary analysis that included prescription criteria, preparedness levels, social, economic and environmental conditions (USDA Northern Region, 1989).

A second lighting strike in Cabin Creek was extinguished by rain before a prescription analysis could be completed (USDA Northern Region, 1989). This second strike most likely occurred during the same storm which initiated the Canyon Creek Fire.

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 34.3
Actual ERC for the day: 38
Seeley Lake Ranger Station; 3-day running mean ERC: 30.0
Actual ERC for the day: 29

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 16.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.6%

Fuels: Duff, logs, brush. Fuel Model G/10. ABLA/CLUN HT, Cover type AF, S. Land Type 13.UB., aspect northeast, slope 20%, lower 1/4 of slope, elevation 5400 (Bailey 1988).

Fire Behavior: Burned area under "worst case" conditions would be approximately 1300 acres, under anticipated conditions approximately 350 acres. This was the projected maximum fire acreage for burning between 7/12-9/1 with six days of fire runs considered in the final total (Bonney, fire projection map, 1988). (Specific conditions considered by Bonney are listed in the July 12th Fire Behavior narrative.) Present size 1/2 acre at 1300 hrs. A small amount of smoke was visible at the time the fire was flown. It appears the fire was creeping upslope in duff. Smoke volume is light with excellent dispersion (Bailey 1988). The size of the burned area was principally the result of scattered hot debris from the lightning struck tree and a small amount of smoldering combustion. Average rate-of-spread from a single source in duff is approximately 1.2 inches per hour (Frandsen interview). Differing rates-of-spread have been measured ranging from 0.2 - 3.9 inches per hour in Tasmania (Sheshukov, 1974), to 1.2 - 4.8 inches per hour calculated from peat fires (Weir, 1983). A general rule-of-thumb used by Australian fire control personnel is about 1.6 inches per hour (Weir, 1983).

Weather Forecast: Short-term forecast predicts wetting rains through the week and cooler temperatures. Associated fire behavior will generate slow to inactive fire spread. NWS indicates normal moisture and temperatures through August. The fire season should progress at a normal rate with no unusual drying anticipated (Bailey 1988).

Fire Weather: Cloudy weather until this date had prevented aerial recon (Impact Anlysis, 1988).

1035 hrs. "Small cumulus clouds few hundred feet above mountain tops." (Lolo National Forest, Fire Dispatch radio log, transmission from Mount Morrel Lookout, Montana Department of State Lands.)

Seeley Lake AFFIRMS weather; Max Temperature 77F, Min Temperature 36F, Max RH 100%, Min Rh 36%; fuel moistures 1 Hr 7%, 10 Hr 12%, 100 Hr 14%, 1000 Hr 17%, woody 126%, herbaceous 95% (Bailey, 1988).

Both the Lincoln and Seeley Lake Ranger Stations reported 0.18" of 24 hr precipitation, The Silver King Lookout reported 0.25" during the same period.

Regional Weather: During the night temperatures cooled into the 50's and 60's over most of the Region, and ranged from 44 at West Yellowstone to 73 at Miles City. Showers and thunderstorms continued to bring some much needed moisture. Some of these storms had large hail, brief heavy rains, and gusty winds. Hail was reported from many locations around western Montana with golf ball sized hail reported from Hamilton, Missoula, and near Kalispell. The storm moved east of the divide late in the day with further large hail reported along the east slopes of the divide. The National Weather Service posted Red Flag Warnings for eastern Montana for gusty winds produced by these thunderstorms. Red Flags were lowered in western Montana, but it was still expected to remain windy. Rainfall amounts varied from between 0.10" west of the divide to over an 1.5" along the east slopes. Further east Miles City received 2.1". The Yellowstone area received some locally heavy showers with up to 0.35" being

recorded. However, most of the the Park remained dry and cloudy. Afternoon high temperatures across the Region extended from the mid-80's to upper 90's (Bushey, 1989).

JUNE 29 (Julian Date 181)

Incident Plan and Decision Notice was signed on this morning by "Acting" District Ranger Dan Bailey (Bailey, 1988).

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 35.3
Actual ERC for the day: 32
Seeley Lake Ranger Station; 3-day running mean ERC: 29.3
Actual ERC for the day: 28

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 14.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 17.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 17.0%

The Lincoln Ranger Station reported 0.01" of 24 hr precipitation, Seeley Lake Ranger Station received 0.03", and Silver King Lookout measured 0.01".

Regional Weather: Morning low temperatures were mostly in the upper 40's and 50's, and ranged from 39 at Grangeville and 42 at Mullan to 69 at Miles City. The frontal system that had triggered the rain and hail the previous day had moved into central Montana and later in the day into eastern Montana providing additional precipitation to the drought stricken eastern plains. The front brought heavy rains and gusty winds and localized reports of hail. A funnel cloud was spotted near Malta. Glasgow had .55" of rain, lessor amounts fell elsewhere. Cooler temperatures poured into the Region behind the front with afternoon highs in the upper 50's and 60's west of the divide and in central Montana and 80's and 90's in the east ahead of the front. Afternoon temperatures ranged from 51 at West Yellowstone to 94 at Billings. Strongest wind gusts were in Livingston with 51 MPH, and several other stations had gusts of 30 to 40 MPH. A surface high pressure ridge edging into the Pacific Northwest was beginning to produce warm, dry westerly winds across the Region (Bushey, 1989).

JUNE 30 (Julian Date 182)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 37.0
Actual ERC for the day: 43
Seeley Lake Ranger Station; 3-day running mean ERC: 30.6
Actual ERC for the day: no data

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 12.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 15.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 17.0%

Regional Weather: The front finally exited the Region during the night, and dry conditions started to return to the western portion of the Region as high pressure began to rebuild. A very dry airmass aloft covered California, Nevada, Utah, eastern Oregon, and southern Idaho. The dry air was spreading into Montana, Wyoming, and Colorado with no indications of any moisture source available. During the night temperatures dropped into near record 30's in the southwest and into the 50's over the rest of the Region, ranging from 29 at West Yellowstone (the national low temperature) to 58 at Miles City. There were some unofficial reports of frost from the Florence-Stevensville area of western Montana. A few showers lingered along the eastern Montana border, otherwise skies were mostly sunny. Afternoon high temperatures were mostly in the 70's, and ranged from 71 at Kalispell to 80 at Thompson Falls (Bushey, 1989).

JULY 1 (Julian Date 183)

The Scapegoat - Danaher Fire Management Plan requires that early season ignitions still burning after July 1st be subject to a Complexity Level Impact Analysis before continuation of the prescription status. This process was stated by the Lolo National Forest on this date with the bringing together of an Impact Analysis Team to evaluate the Canyon Creek Fire and present and projected burning conditions (USDA Northern Region, 1988). This date is the official start of the fire season, and fires burning in the units of the Scapegoat Wilderness driven by the Lincoln Ranger Station's weather data are recommended to be below the 90th percentile for the July 1 - August 25 period (ERC=62 based on the Fire Management Plan) to be within prescription.

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 40.6
Actual ERC for the day: 44
Seeley Lake Ranger Station; 3-day running mean ERC: 33.3
Actual ERC for the day: 33

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 12.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.6%

Regional Weather: A stationary high pressure ridge extended from New Mexico to eastern Montana keeping temperatures warm. Skies were generally fair across the Region during the night and morning. Morning low temperatures were 30's in the southwest, 50's in eastern Montana, elsewhere in the 40's. West Yellowstone was the cold spot with 31 degrees and ranged to 55 at Billings. During the afternoon most of the Region was sunny with high, thin clouds, some mid-level clouds were moving into the northwest. Winds were light at 5 to 15 MPH. Afternoon temperatures were mostly in the 80's, ranging from 76 in Mullan and 77 in Grangeville to 94 at Hardin (Bushey, 1989).

JULY 2 (Julian Date 184)

Fire observed by Bob Keane, wilderness hiker, about 1200 hrs on his way out of the Scapegoat. Smoke was visible from 1/4 to 1/2 mile down trail. No visible flame as the fire was smoldering in duff and down fuel.

2052 hrs. "Hiker reported fire at junction of Canyon Creek and the Dry Fork - Section 11, T17N, R11W. Told him this was one of our Rx fires. Told him about Cabin Creek also." (Lolo National Forest, Fire Dispatch radio log, message from the Flathead National Forest)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 41.3
Actual ERC for the day: 44
Seeley Lake Ranger Station; 3-day running mean ERC: 34.3
Actual ERC for the day: 35

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 11.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.3%

Regional Weather: Skies were clear to partly cloudy during the night, with no precipitation reported in the Region. High pressure aloft remained over the Northern Rockies with a dry stable southwest airflow. Winds were generally light, except for the Miles City area where winds were southeast at 15 to 25 MPH. Low morning temperatures ranged from the mid-30's in the southwest to the mid-60's in the east. The coolest location was West Yellowstone with 37 degrees, the warmest was Miles City at 63. As the afternoon progressed high thin cloudiness covered the Region and winds remained generally light except along the east slopes where they gusted to 25 to 35 MPH. Gusts of 25 to 30 MPH were also reported in the Missoula area. Afternoon high temperatures were mostly in the 90's with Glendive reporting at 102 (Bushey, 1989).

Miscellaneous: The Palmer Drought Severity Index indicated that the majority of the Region remained under extreme soil drought conditions. Only northern Idaho exhibited some moist soils (Bushey, 1989).

JULY 3 (Julian Date 185)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 40.3
Actual ERC for the day: 45
Seeley Lake Ranger Station; 3-day running mean ERC: 35.0
Actual ERC for the day: 35

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 10.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%

Regional Weather: Skies were partly cloudy over the Region during the night with a few scattered thunderstorms in eastern Montana and some showers in western Montana. A weak weather system moved across the northwestern corner of the Region during the morning producing the showers. Winds were generally 15 MPH or less except in the vicintiy of the thunderstorms and along the eastern Montana border. Cutbank reported wind gusts to 30 MPH and Miles City recorded winds from 15 to 20 MPH. Low morning temperatures ranged from the 40's in the

southwest to the low 70's in the east. The coolest location was West Yellowstone at 45, the warmest was Jordan with 72. Widely scattered thunderstorms developed over the southwest during the afternoon and spread north into central Montana. By late afternoon widely scattered thunderstorms were occurring near Lewistown to Great Falls and the continental divide. A thunderstorm also passed over Missoula and dropped .25" of rain within 10 minutes. Elsewhere skies were partly cloudy across the west and sunny in the east with winds less than 15 MPH. Afternoon high temperatures were in the mid-80's to the mid-90's in the east and in the 70's in the west. Temperatures ranged from 72 degrees at Mullan and Grangeville to 102 degrees at Hardin. The shower and thunderstorm activity continued across the Region most of the night as another weak weather disturbance moved east from the Pacific Northwest. A low pressure system along the west coast was expected to get stronger during the next several days and produce some weak weather systems which would head toward the Region. This would produce a more southerly air flow and bring some moisture north as well (Bushey, 1989).

JULY 4 (Julian Date 186)

0935 hrs. "Guestimate 1/4 inch rain (at Seeley Lake)." (Lolo National Forest, Fire Dispatch radio log.)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 33.3
Actual ERC for the day: 41
Seeley Lake Ranger Station; 3-day running mean ERC: 33.3
Actual ERC for the day: no data

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 20.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 12.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%

Regional Weather: Some thunderstorm activity from the previous night was still being reported this morning at Cutbank, Great Falls, and Havre. The Lincoln Ranger Station reported at 1400 hrs that their 24 hr precipitation resulted in a 0.11 inch accumulation. Otherwise the Regions skies were of varying degrees of cloudiness with partly cloudy being the best descriptor. Overnight low temperatures at most locations were in the 40's and 50's, and ranged from 43 degrees at Mullan to 71 at Broadus. Thunderstorm activity again started to build during the afternoon and were widespread over the eastern two-third's of the Region by the late afternoon. Severe thunderstorm watches were in effect for most of central and eastern Montana until 2200 hrs. In addition, a flash flood warning had been issued for southeast Cascade County where thunderstorms were dropping heavy rain during the late afternoon and evening. Great Falls reported .5" of rain in the six hour period from 1200 to 1800 hrs. Afternoon high temperatures were mostly in the 80's and 90's east of the divide, and 70's to mid-80's on the westside. Cutbank was the coolest location with 77 degrees, and the warm spots were Broadus and Miles City at 93. The low pressure system along the west coast was expected to continue sending sending a series of weak weather disturbances into the Region that would keep conditions unsettled for the next several days. The main low was expected to eventually weaken and move

east, bringing a cooler and drier airmass as the current high pressure aloft retreated (Bushey, 1989).

JULY 5 (Julian Date 187)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 32.3
Actual ERC for the day: 19
Seeley Lake Ranger Station; 3-day running mean ERC: 32.0
Actual ERC for the day: 31

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 21.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 14.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%

Regional Weather: Skies were mostly cloudy across the Region during the night as scattered showers lingered and some thunder was reported from the Great Falls and Cutbank areas. Fog was reported near daybreak at Great Falls and Belgrade. Winds were generally 15 MPH or less except in the vicinity of thunderstorms and in the northwest corner. Kalispell occasionally reported winds 15 to 30 MPH. Low temperatures across the Region were in the 50's in the west and the 60's in the east. The coolest was Mullan, Idaho with 46, and the warmest location was 68 at Broadus and Glendive. Afternoon high temperatures west of the divide were in the 50 and 60's, 70's just to the east of the divide, and into the 90's and 100's in the eastern third of the Region. Mullan and Grangeville, Idaho only had high temperatures of 55 degrees, Thompson Falls had 59; while in the east it was 104 in Broadus for the warmest location. During the afternoon two tornadoes were sighted along the Northern Rockies, one in the Big Hole country of southwestern Montana and the other between Great Falls and Helena. There were several reports of hail storms in southwestern Montana, and Great Falls was drenched with just under an inch of rain. Seeley Lake Ranger Station reported a 24 hr precipitation total of 0.09 inches. Lincoln received 0.29 inches for the previous 24 hrs ending at 1400 hrs. The drought stricken eastern plains did not receive any general rains and it was still drier than the dust bowel days of the 1930's. This precipitation was produced by an active low pressure system moving northeast into Canada (Bushey, 1989).

Long-Range Weather Forecast: Missoula Fire Weather Office issued a weekly summary and a long-range outlook of the weather. The 30-day outlook was, "THE MONTH OF JULY NEAR NORMAL PRECIPITATION AND NEAR TO A LITTLE BELOW NORMAL TEMPERATURES." The 90-day outlook was, "JULY THROUGH SEPTEMBER BELOW NORMAL TEMPERATURES AND NEAR OR SLIGHTLY ABOVE PRECIPITATION" (USDA Northern Region, 1989; Bushey, 1989).

JULY 6 (Julian Date 188)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 33.3
Actual ERC for the day: no data
Seeley Lake Ranger Station; 3-day running mean ERC: 32.0
Actual ERC for the day: no data

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 21.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 14.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%

Regional Weather: Cooler and drier air spread into the Region as the last of a series of weather systems moved through from the west. Cloudy skies and widely scattered showers continued until 0600 hrs. Morning low temperatures ranged from 41 degrees at West Yellowstone, Mullan, and Thompson Falls to 64 at Broadus. During the afternoon a strong low pressure system in Alberta was causing winds to increase along the east slopes of the Rockies. Gusts reached 68 MPH at Livingston, Cutbank and Great Falls had gusts of 40 to 50 MPH. Afternoon temperatures ranged from the upper 50's in the northwest to the 80's in the southeast, and ranged from 56 at Libby to 91 at Broadus. The high of 65 degrees in Missoula was about 20 degrees below normal for the time of the year. A more stable westerly airflow developed by the end of the day and a return to a warming, drying trend was expected as high pressure rebuilt (Bushey, 1989).

JULY 7 (Julian Date 189)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 41.0
Actual ERC for the day: 40
Seeley Lake Ranger Station; 3-day running mean ERC: 34.6
Actual ERC for the day: 34

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 12.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 11.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%

Fire Behavior: Nothing seen from the air (1700 hrs +/-) by Sisk (Bailey and others, 1988).

1814 hrs. "No smoke showing in either fire in the Scapegoat." (Lolo National Forest, Fire Dispatch radio log.)

Regional Weather: Skies were generally clear and winds light across the Region during the night and with the clear skies morning low temperatures were very cool before sunrise. At 0600 hrs West Yellowstone was the coolest with 29 degrees, Butte dropped to 32, followed by Missoula and Lewistown with 36. In shady areas around Missoula frost was reported on roofs and lawns. As the high pressure returned during the day it brought sunny skies, mild temperatures and low humidities (25 to 35%) across the Region. Afternoon temperatures were in the 70's and low 80's, and ranged from 74 at Cutbank to 85 at Miles City and Broadus (Bushey, 1989).

JULY 8 (Julian Date 190)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 42.8
Actual ERC for the day: no data
Seeley Lake Ranger Station; 3-day running mean ERC: 38.0
Actual ERC for the day: 38

The Seeley Lake Ranger Station moved above the ERC 80th percentile level (ERC = 37), based on the 1973-1987 seasons, for the first time in 1988. ERC levels above the 80th percentile would be maintained for another five days before the ERC level would briefly drop.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 7.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 14.6%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%

Fire Behavior:

1400 hrs. "Fire in Scapegoat is hot. One acre and growing in duff, small patches of flame." (Lolo National Forest, Fire Dispatch radio log.)

Wilderness guard reported fire at 1 acre, hot with some flame. Fire showed very little smoke after several aerial passes around 1800 hrs. This was the first time the fire had been sighted since July 1 (USDA Northern Region, 1989). Fire became active during the afternoon (Bailey and others, 1988). Light gray, wispy smoke from the slope above the Dry Fork of the North Fork of the Blackfoot River. No scorch was evident on the tree crowns as seen in a Lolo National Forest video taken of the fire.

Using the following estimates of a corrected fine fuel moisture value range of 6-18%, 10 Hr of 12%, 100 Hr of 14%, Live Woody Moisture content of 126%, and light upslope winds of 0 - 1 MPH corrected midflame wind speed, with a 30% slope in Fuel Model 10 a maximum fire behavior upslope rate-of-spread range of 1 to 2 chains per hour with maximum 1.9 - 2.8 ft flame lengths were possible for a short period of time during the late afternoon. Most behavior during the day was evidently not of the flaming type, but active smoldering.

Regional Weather: Skies were clear during the night as high pressure aloft dominated. Winds were generally light and 10 MPH or less. Temperatures dropped into the low 40's west of the divide with 60's in the southeast. Overnight lows ranged from 31 at West Yellowstone to 62 degrees at Miles City. The afternoon brought sunny skies and low humidities (10 to 25%) with temperatures in the upper 70's and 80's with a few 90's in the southeast. Winds were mostly 5 to 15 MPH. A broad ridge of high pressure continued over the Intermountain Region causing a westerly airflow that was bringing the warm, dry air to the Northern Region. The ridge was also keeping subtropical moisture to the south and pushing any Pacific storms to the north (Bushey, 1989).

Weather Summary for the Week Ending July 8th.

Station	Temperature High	Temperature Low	Precipitation Past Week	Precipitation % Normal
Missoula	89	41	0.47	124
Helena	89	44	0.19	101
Augusta	87	40	0.71	57

Precipitation normals represent accumulations since April 1st in Montana.

JULY 9 (Julian Date 191)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 43.6
Actual ERC for the day: 40
Seeley Lake Ranger Station; 3-day running mean ERC: 40.3
Actual ERC for the day: 44

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 14.3%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%

Measured Fuel Moistures: 10 Hr under forest canopy 10-12%
10 Hr on exposed south slope 8-10%
High soil moisture below duff (Williams, 1988).

Fuel: Heavy fuel and reproduction above the fire area, MEFE and alder above pond area. Fire in Fire Group 9 ABLA/CLUN/MEFE HT, 150 year old stand and coming apart (Williams, 1988).

Fire Behavior: Has potential for some movement, prevailing upslope and up canyon winds. Next 5 days could be 25+/- acres. Low prospects of crossing Dry Fork. Expect change in behavior next week to 10 days. Fire has been smoldering with lowest RH of 14%. 3 other spots are all out but a spark started this one (Williams, 1988). J. Williams, B. Bonney and K. Brown flew the fire during the afternoon, was between 1/2 and 3/4's of an acre with visible smoke (Bailey and others, 1988). Smoke was not seen on the first 2 passes finally found on the third, fire not active (Bonney, 1988).

Regional Weather: Skies remained clear during the night as high pressure dominated the Region. Winds were light and generally 10 MPH or less. Morning temperatures dropped into the 40's west of the divide, and into the 50's and 60's in the south and east. Low temperatures ranged from 35 at West Yellowstone to 58 at Billings. Afternoon skies remained sunny, even with an upper level disturbance which moved through the northern portions of the Region. A few high, thin clouds were about all that the disturbance could produce. In the south a few puffy, low clouds popped up, but no rain occurred. Afternoon high temperatures were in the upper 80's and lower 90's, and ranged from 82 at Cutbank to 92 at Thompson Falls and Broadus (Bushey, 1989).

Miscellaneous: The Palmer Drought Severity Index indicated worsening conditions within the Region as areas of moderate or severe drought were further reduced in extent and changed to extreme. Only northern Idaho remained moist (Bushey, 1989).

JULY 10 (Julian Date 192)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 43.3
Actual ERC for the day: 46
Seeley Lake Ranger Station; 3-day running mean ERC: 41.3
Actual ERC for the day: 41

The Seeley Lake Ranger Station briefly exceeded the ERC 90th percentile level (ERC = 41), based on the 1973-1987 seasons, on this one day before dropping lower.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 14.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%

Fire Behavior: Bailey and Bonney flew fire and no smoke was visible (Bailey and others, 1988). Bonney rode into fire and arrived about 1000 hrs. Light smoke was coming up from the fire area. The original lightning struck Douglas fir was found up on the ridge above the cutoff trail. The fire around the tree was out. The fire had spotted earlier and was now burning on the ridge top 40 feet from the original fire. The fire had spread down slope to the bottom of the slope about 200 feet. It had rolled down a chute between two rock outcrops and was smoking most active right at the bottom of the fire near the cutoff trail and at the very top of the ridge. Wind during the afternoon was blowing upslope (Bonney, 1988). Fire behavior was mostly active smoldering with some minor flaming activity in the down and dead woody fuel.

Regional Weather: Skies were clear to partly cloudy during the night with variable mid to high level clouds over portions of Montana. Billings radar indicated a few showers in southern Big Horn and Rosebud Counties of southcentral Montana early in the morning. These showers and clouds were caused by an upper level disturbance which moved eastward across the Region. Nighttime temperatures dropped into the 40's in the southwest valleys, elsewhere temperatures were in the 50's and areas with clouds had 60's. Morning lows ranged from 41 at West Yellowstone to 65 at Miles City. High pressure, now centered over southcentral Canada, continued to be the dominant weather influence. A few thunderstorms developed in the southern half of Montana during the afternoon, and 15 to 25 MPH east winds were common across the plains. Afternoon temperatures were warmest west of the continental divide were 90's occurred, to the east temperatures rose into the 80's. High temperatures ranged from 82 at Livingston to 99 at Thompson Falls. During the night scattered thunderstorms started to appear and lightning was observed north of Billings (Bushey, 1989).

1810 hrs. The Silver King Lookout reported thunderstorm activity in the Stonewall, Big Blackfoot, and Lincoln Valley areas moving east. (Silver King Lookout radio log.)

JULY 11 (Julian Date 193)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 43.3
Actual ERC for the day: 43
Seeley Lake Ranger Station; 3-day running mean ERC: 40.6
Actual ERC for the day: 40

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 14.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.6%

Regional Weather: Skies were clear to partly cloud during the night over most of the Region. Scattered thunderstorms in central and southcentral Montana developed as a weak disturbance passed through heading east. At 0500 hrs Billings radar still indicated a persistent thunderstorm moving slowly eastward across parts of central Montana between Billings and Miles City. Overnight low temperatures were in the low to mid-50's west of the divide, elsewhere readings were in the low and mid-60's. Low morning temperatures ranged from 42 at West Yellowstone to 63 at Miles City. High pressure, now centered over Manitoba, was moving east and ending the several days of warm, dry weather. A Pacific cold front in eastern Washington was spreading clouds across the Region, and with generally partly cloudy skies widely scattered thunderstorms were developing in western Montana. Helena reported hail from a thunderstorm. Lincoln Ranger Station reported an accumulation of 0.06 inches of rain during the 24 hrs preceding 1400 hrs. Afternoon temperatures were in the 80's and low 90's, and east winds were common across the eastern plains with speeds of 15 to 30 MPH. Afternoon high temperatures ranged from only 72 at Libby to 97 degrees at Hardin. Thunderstorms developed across central Montana during the night and produced brief, locally heavy showers. Broadus recorded .25" of rainfall before midnight (Bushey, 1989).

1345 hrs. Silver King Lookout reported thunderstorm cells to the west, southwest, and south.

1400 hrs. Lighting is observed from the Silver King Lookout. One fire start is reported at 1420 hrs about 6 miles southeast of the lookout. This fire was jumped and hit with retardant.

1530 hrs. Another thunderstorm cell developing over the Blackfoot Valley with lightning and strong winds, 16-22 MPH and increasing. This storm moves over the Silver King lookout at 1548 hrs with "lightning too numerous to count, all south of Silver King." Storms continued to develop and produce lightning through the night. Most had little rain, though locally heavy showers did occur. The lookout reported .03" of rain during the day, most in sudden down pours. (Silver King Lookout radio log.)

Miscellaneous: If fire is controlled it could be limited to 1 acre of growth. Contain and confine are not realistic options. Controlling the fire would avoid any political/social issues that may develop over a 5 week period under warming, drying conditions. Missed opportunities would include allowing re-introduction of natural fire (stand is coming apart, continuous over a large area). As a prescribed fire expected final size is 600 acres and would improve grizzly habitat, meet wilderness intent (diversity), and create diverse vegetation mosaic and future fire behavior. Disadvantages would include potential impacts on watersheds, with siltation and fisheries impacts (Williams, 1988).

JULY 12 (Julian Date 194)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 42.6
Actual ERC for the day: 44
Seeley Lake Ranger Station; 3-day running mean ERC: 37.6
Actual ERC for the day: 39

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 9.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 14.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.3%

Jerry Williams (Lolo Forest Fire Management Officer) met with Lolo Forest Supervisor Orville Daniels and explained the analysis behind the Impact Teams recommendation to allow the Canyon Creek Fire to continue as a prescribed natural fire in the wilderness. After talking with Chuck Spoon (Lolo Forest Program Officer for Resources) and Williams, Daniels agreed with the teams recommendation (USDA Northern Region, 1989).

Fuels: Same types, models, groups, ht's, cover types, land types as noted previously. Loadings averaging 15-40 tons/acre. Current 1000 Hr fuels for the general area range from 15-20% (Bailey and others, 1988).

Fire Behavior: Size was still listed as 1 acre. Projected fire area under normal anticipated conditions 600 acres, probability of this occurring between 7/12-9/1 is 70%. Fire spread would be to the west and upslope from current fire. No abnormal weather events to trigger erratic or extreme fire behavior. Normal afternoon light upslope winds would push fire further up the slope to the ridge. Normal drying of the forest fuel would occur with 1 hr reaching 5%, 10 hr equaling 8% and 100 hr about 10%. The fire would reach the first ridgeline above the current fire area and basically stop near the ridge. The timber type changes on this ridge to the north and west to more of a lodgepole component and probably would not carry fire quite as readily as the expected burned area. Historically the fall season begins after August 25th due to wetter weather conditions. This would be about the time the fire would be finished with its forward rate-of-spread.

Projected fire area under most severe weather conditions 3400 acre, probability of this occurring between 7/12-9/1 is 20%. There looks to be a timber type change to lodgepole pine from the north and east of Canyon point down to the mouth of Dwight Creek and down the Dry Fork about a mile. The photos show a tighter texture of timber like a younger lodgepole stand which,

even under more severe conditions, would not be likely to support fire very well especially with the expected wind condition. A six day fire run was figured for this projection. During this time the winds would be upslope toward Canyon Point for 3 days then a frontal passage would push the fire from northwest to southeast toward Canyon Creek for 3 more days. The topography plays a big part in retarding some of the fire spread to the west and to the SE. There are several fingers ridges and deep side drainages that would detract from a normal fire spread model. Fuel moisture conditions were figured to be 1 hour 3%, 10 hour 5%, and 100 hour 7%. Spotting will occur but was not used in the forward rate-of-spread.

Exceeding historical most severe weather conditions 30,000 acres, probability of this occurring between 7/12-9/1 is 10% (Bailey and others, 1988).

Miscellaneous: A third lightning strike occurred near the Falls Point Lookout. This fire was suppressed to avoid the possibility of having two interactive fires later in the summer (USDA Northern Region, 1989).

Regional Weather: A Pacific cold front moved through Montana during the night triggering numerous showers and thunderstorms, some quite heavy. Lincoln Ranger Station reported 0.01 inches for the 24 hr period ending at 1400 hrs. With variable cloudiness and scattered showers across the Region most places had low temperatures only in the upper 50's to upper 60's. Morning low temperatures ranged from 49 in Mullan and Grangeville (51 in Drummond, Butte, and Lewistown) to 66 in Miles City. The weather system was rapidly pushed out of the Region by a fast jetstream from the west. Thunderstorms ended in eastern Montana early in the morning, with only isolated ones building in the east during the afternoon. Elsewhere afternoon skies were partly to mostly cloudy. High temperatures for the day were cooler than earlier days ranging from the upper 60's and lower 70's in the western mountains to the upper 80's in the southeastern grasslands. Afternoon temperatures ranged from the high at Wisdom with 68 (Missoula, Kalispell, and Thompson Falls only reached 69) to 92 degrees at Gardiner just to the north of Yellowstone National Park. It was also a windy day over most of the Region. Cutbank reported gusts to 48 MPH, Great Falls had 47 MPH gusts, and a number of other stations reported gusts over 30 MPH (Bushey, 1989).

Weather Forecast: Short Range; The weather pattern for the 2nd half of July looks similar to the pattern that has prevailed since last spring. A strong high pressure will be locked in over the west central US and low pressure will remain n the Gulf of Alaska. For Canyon Creek Fire there looks to be near or a little above normal precipitation as the monsoon into the southern and central Intermountain region should develop. No extended hot and dry period is foreseen as there is expected to be a lot of tropical moisture available and should not be restricted in moving northward into Montana's mountain areas. With the Low of the Northwest Coast, there will most likely be weak or moderate fronts drifting inland on a fairly regular basis. This will aid in drawing up moisture, and should cause temperatures to oscillate, therefore not getting to hot for to long.

Long Range; NWS products indicate a trend toward below normal temperatures and near or slightly above normal precipitation. Possibly of fall-like storm systems to move inland prematurely if precipitation is above normal the rest of the summer (Bailey and others, 1988).

JULY 13 (Julian Date 195)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 41.6
Actual ERC for the day: 43
Seeley Lake Ranger Station; 3-day running mean ERC: 32.6
Actual ERC for the day: 33

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 15.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 14.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.3%

Fire Behavior: Members of the Bob Marshall Wilderness Complex Management Team observed the fire on the ground. The fire was cold on the hill to the west, but it had alot of heat along the east edge. Very little flame was observed. (USDA Northern Region, 1989)

Regional Weather: There was variable cloudiness, areas of gusty west winds, and a few showers across the Region during the night. Low temperatures for the morning were mostly in the 50's and 60's, and ranged from 41 degrees at West Yellowstone to 67 at Miles City. During the afternoon sunny skies developed over Yellowstone National Park and southwestern Montana, becoming partly cloudy over the Bitterroot Valley, then overcast from Missoula north into Glacier National Park. A few light showers occurred over the northwestern portion of the Region during the morning hours. Lincoln Ranger Station received 0.01 inches of moisture in the 24 hr period preceding 1400 hrs. Westerly upper airflow was slowly pushing these clouds to the east. The cool, moist air and westerly airflow was associated with a very strong jetstream which was south of the Canadian border. Afternoon high temperatures ranged from the upper 60's west of the continental divide to the lower 90's in southcentral Montana, Mullan was the afternoon cool spot with a high of 63 degrees while Broadus recorded a reading of 98. During the evening rainshowers again started in the western Montana, northern Idaho areas (Bushey, 1989).

0745 hrs. Silver King is socked in, .02" raining, winds west 15-20, 38 degrees." (Silver King Lookout radio log.)

1000 hrs. "Ceiling at 7800 and lifting." (Silver King Lookout radio log.)

1200 hrs. "Clouds breaking patches sun showing through." (Silver King Lookout radio log.)

Miscellaneous: The USFS Northern Region goes to Fire Preparedness Level 2 (Bushey, 1989).

JULY 14 (Julian Date 196)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 41.0
Actual ERC for the day: 39
Seeley Lake Ranger Station; 3-day running mean ERC: 31.3
Actual ERC for the day: 25

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 16.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 14.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.6%

Regional Weather: The last of a series of minor upper air disturbances were passing over western Montana during the morning. The cold front brought light rainshowers throughout that area, in Missoula it was the fifth day of measurable precipitation bringing this months total to almost 0.5 inches. The Seeley Lake Ranger Station reported a 24 hr moisture total of 0.09 inches as of 1400 hrs. Morning low temperatures were mostly in the 50's across the Region, and ranged from 46 at Butte to 73 at Broadus. Afternoon skies were partly cloudy in the southeast to mostly cloudy in the northwest portions of the Region. By evening the cold front extended from Havre southwest to near Butte and was slowly moving eastward. Some isolated shower activity had been reported along the front, mostly in western Montana and along the hi-line into the Havre area. Behind the front winds were gusty, areas along the eastern slopes of the Rockies were reporting gusts 30 to 35 MPH. Most stations had less than 15 MPH winds. Afternoon high temperatures ranged from the 60's in the west behind the front to between 95 and 108 in the east and southeast. Extremes ranged from 64 degrees at Hamilton to 108 recorded at Broadus. It was also very warm at Baker with 107, and Glendive at 104. A strong pressure gradient starting to build over the Pacific Northwest was expected to bring drying winds to the area. A very dry airmass persisted over California, western Arizona, Nevada, and southwest Idaho (Bushey, 1989).

0800 hrs. "Socked in ground fog - no moisture." (Silver King Lookout radio log.)

1200 hrs. "Raining lightly." (Silver King Lookout radio log.)

1442 hrs. "Ceiling 8700', peaks in clouds; Red, Caribou, Nevada, Black Mountain." (Silver King Lookout radio log.)

JULY 15 (Julian Date 197)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 41.6
Actual ERC for the day: 43
Seeley Lake Ranger Station; 3-day running mean ERC: 32.6
Actual ERC for the day: no data

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 13.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 14.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%

Regional Weather: Radar indicated a few scattered showers during the night, but none of the regular reporting stations recorded any nighttime precipitation. Skies across the Region were clear to partly cloudy during the night. Morning low temperatures were in the 30's in the higher southwestern

valleys and near 65 in the southcentral portion of the Region. These low readings ranged from 39 at Missoula to 62 in Billings. Thunderstorms began developing in southwest Montana during the afternoon and moved toward the central portion of the state. Most of the activity was light, with trace amounts of precipitation, and gusty winds between 30 and 40 MPH. This activity was triggered by another weak upper air disturbance and most of the storms fell apart by midnight, but not until dropping a little moisture on portions of eastern Montana. Most areas had afternoon high temperatures in the 80's and 90's, and ranged from 75 degrees at Libby to 97 in Hardin (Bushey, 1989).

Weather Summary for the Week Ending July 15th.

	Temperature		Precipitation	
Station	High	Low	Past Week	% Normal
Missoula	93	39	0.10	121
Helena	91	52	0.17	94
Augusta	88	43	NONE	55

Precipitation normals represent accumulation since April 1st in Montana.

JULY 16 (Julian Date 198)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 43.6
Actual ERC for the day: 45
Seeley Lake Ranger Station; 3-day running mean ERC: 37.0
Actual ERC for the day: no data

The ERC 80th percentile level (ERC = 37) is again achieved at the Seeley Lake Ranger Station and would be maintained above this level until September 9th.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 8.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 14.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%

Regional Weather: Since midnight skies over the Region were mostly fair, with light winds at most locations. Low morning temperatures were in the 50's and 60's, ranging from 40 at West Yellowstone to 68 in Miles City. Upper air westerly winds spilled down the east slopes of the Rockies and created breezy conditions on the eastside of Glacier National Park and into the Cutbank and Great Falls areas. High pressure continued to slowly rebuild over the Northern Rockies during the afternoon and resulted in mostly sunny skies over the Region. Winds were generally light, though Missoula reported some afternoon gusts around 20 to 25 MPH and the Glasgow area had northerly winds gusting to 25 to 30 MPH. High temperatures were mostly in the 80's during the afternoon, and ranged from 79 at both Cutbank and Kalispell to 90 degrees at Miles City. Another weak upper level disturbance started to enter the Region from the west during the evening and produced scattered shower activity in southern Montana. A rather flat ridge of high pressure remained the dominant weather feature over

the western United States. This ridge was expected to stay inplace and strengthen during the next several days producing warmer daytime temperatures.

The 30 day outlook from mid-July to mid-August indicated that temperatures would range from near normal over northern Idaho to above normal east of the continental divide. Precipitation was predicted to be near normal across the Region (Bushey, 1989).

JULY 17 (Julian Date 199)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 45.3
Actual ERC for the day: 46
Seeley Lake Ranger Station; 3-day running mean ERC: 38.6
Actual ERC for the day: no data

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 7.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 14.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%

Regional Weather: A weak upper level disturbance in the westerly flow aloft moved over the Region during the night and early morning. Fair skies prevailed over most of the Region, except for the eastern third where mostly cloudy skies still reflected the influence of the disturbance. Overnight low temperatures were mild and mostly in the 50's and 60's, and ranged from 45 at Kalispell to 68 at Miles City. By early afternoon the temperatures had climbed into the 70's at most locations and was fast approaching the 80's at others. Variable cloudiness covered portions of the Region during the afternoon as some shower and thunderstorm activity developed over the southwestern mountains of Montana, and also over the central part of the state and into the northeast corner of the Region. Gusty winds of 25 to 35 MPH occurred late in the afternoon in Great Falls, Helena, Cutbank, and some areas in western Montana valleys. West Yellowstone also reported gusts to 46 MPH associated with a shower. Most of the precipitation was very scattered and light. Afternoon high temperatures were relatively mild for the middle of July with highs ranging from 76 degrees at Glasgow to 92 at Broadus with most temperatures in the 80's. Afternoon air flow was mostly out of the northwest off a high pressure ridge over the Pacific Northwest coast which continued to build in strength. With pressure on the rise the weather was expected to be hot and dry (Bushey, 1989).

JULY 18 (Julian Date 200)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 46.3
Actual ERC for the day: 48
Seeley Lake Ranger Station; 3-day running mean ERC: 39.6
Actual ERC for the day: 40

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 6.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 13.6%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.6%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 11-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 14-4%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 50-78
Monture 24 hr relative humidity range: 22-55%
(figures 46 - 47)

Regional Weather: Skies were generally clear during the night and morning across the Region. A weak weather system moving east through southern Canada trailed the southern end of that system into eastern Montana where it produced some clouds all through the morning. Overnight low temperatures were in the 40's at most locations, and ranged from 37 at West Yellowstone to 55 at Billings. At midday the western mountains were under mostly sunny skies with a few clouds forming over the mountains. Eastern Montana was partly cloudy and cooler than the day before. During the afternoon a few showers and thunderstorms developed in northern Montana east of the divide. Precipitation amounts were very light. These showers moved into eastern Montana during the evening. The northwesterly flow brought cooler afternoon high temperatures to the Region which ranged from 70 at Cutbank to 87 in Thompson Falls. Gusty north to east surface winds of 15 to 30 MPH occurred much of the afternoon in westcentral Montana (Bushey, 1989).

1602 hrs. "Raining enough to wet the ground." (Silver King Lookout radio log.)

JULY 19 (Julian Date 201)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 47.6
Actual ERC for the day: 48
Seeley Lake Ranger Station; 3-day running mean ERC: 40.6
Actual ERC for the day: 40

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 8.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 6.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 13.3%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 11-5%
Monture, 24 hr High-Low range, 10 Hr fuel: 13-5%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 15-8% at 5400 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 9-8%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 48-70
Monture 24 hr relative humidity range: 25-53%

Regional Weather: Skies were generally clear over most of the Region except for some cloudy skies and widely scattered showers in eastern Montana during the early morning hours. Overnight low temperatures were mostly in the 40's and 50's, and ranged from 34 at West Yellowstone to 53 degrees at Miles City and Billings. Strong surface high pressure over the Northern Rockies continued to dominate the weather pattern across the Region, and in the upper atmosphere

Figure 46. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for July 18 - July 22, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

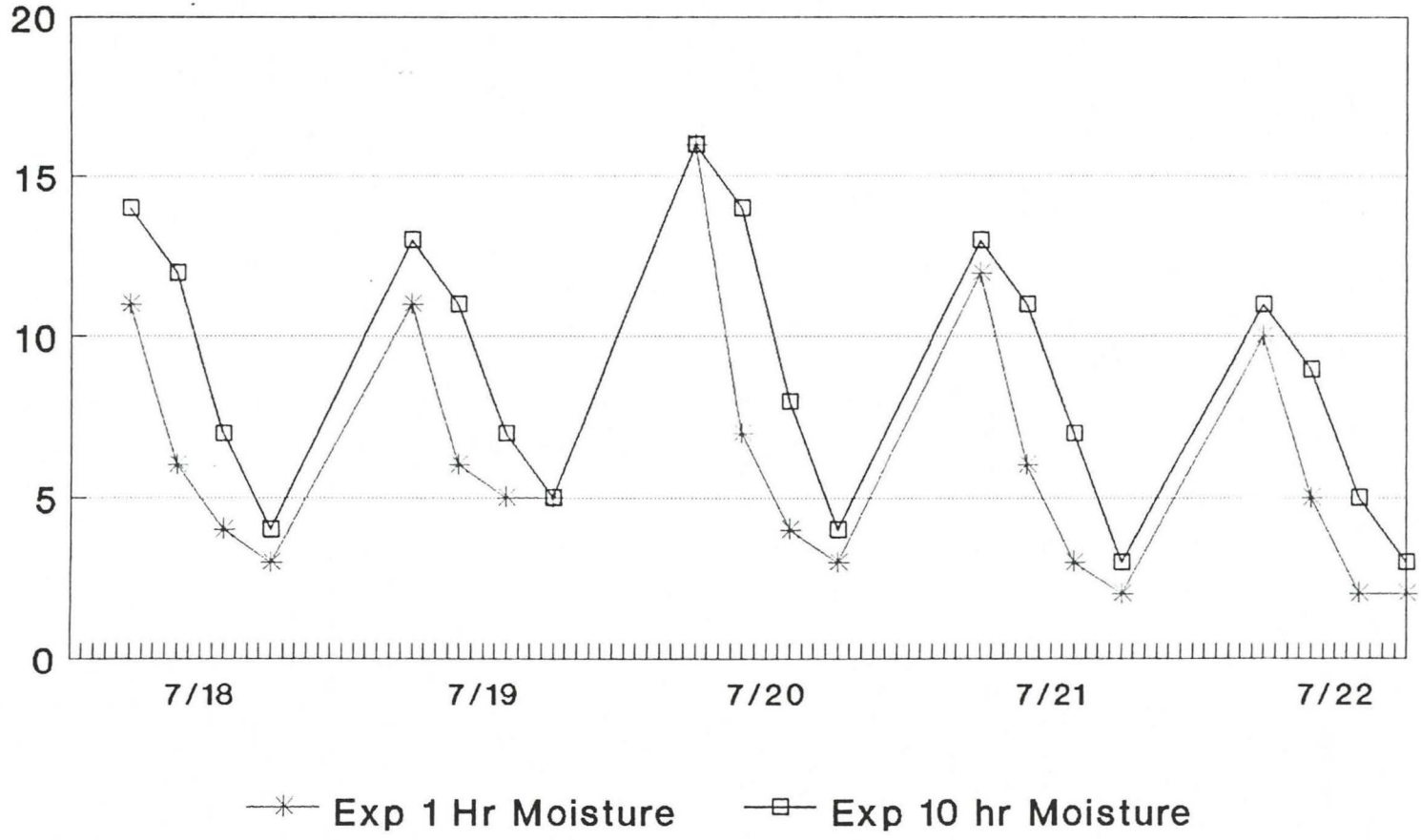
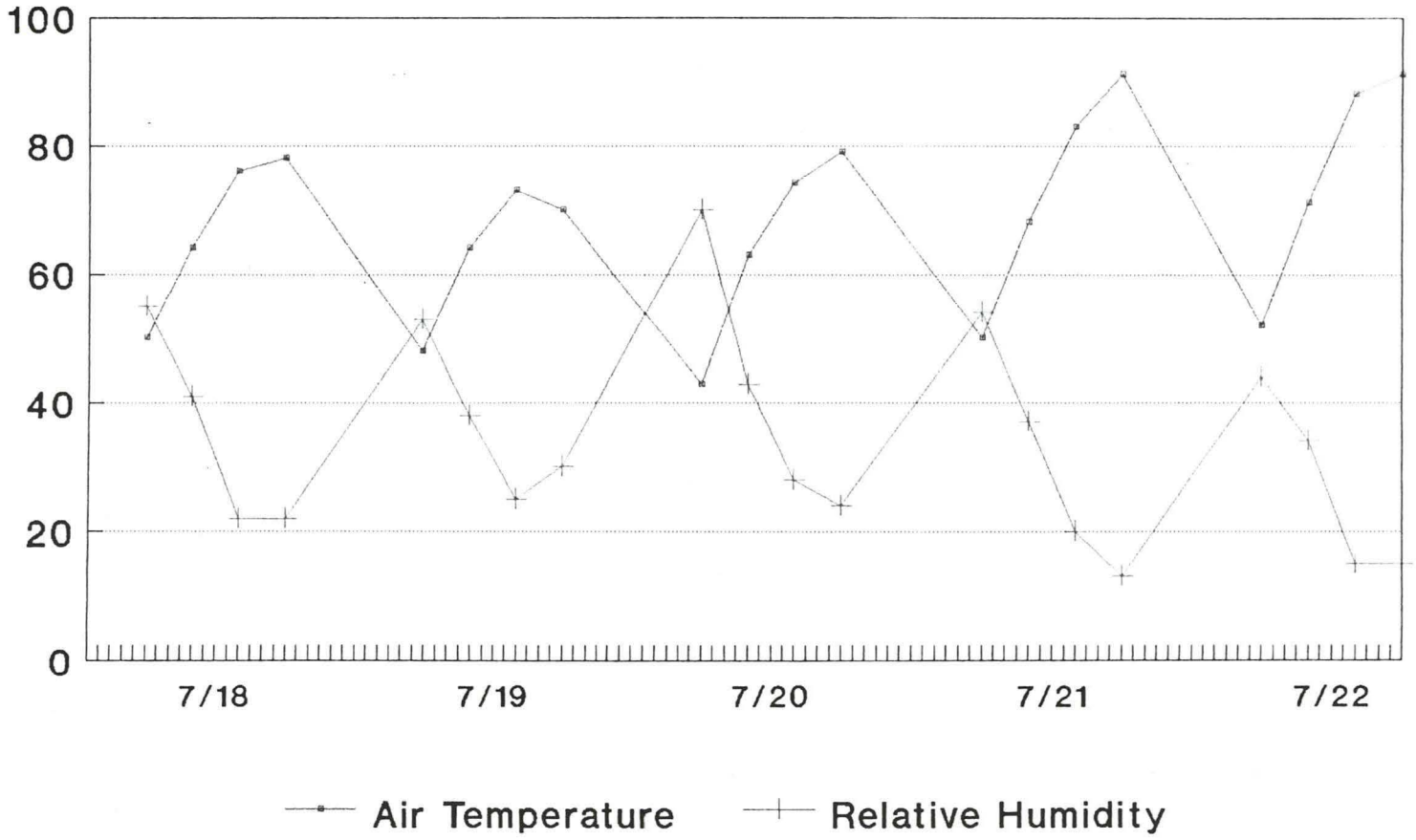


Figure 47. Monture RAWS Station air temperature and relative humidity measurements for July 18 - July 22, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)



the ridge of high pressure remained very strong over the Pacific coast. A thermal trough of low pressure was working its way north from California into the Pacific Northwest and had brought unusual warm weather to the normally cooler sections of Washington and Oregon. Portland had a high temperature of 99 degrees, and Settle was 95. The thermal trough was gradually spreading eastward and warmer temperatures were expected to edge into the Region. These warmer temperatures were starting to be reflected in the high temperatures starting to occur in northern Idaho and northwest Montana. Afternoon high temperatures across the Region were mostly in the mid-70's to mid-80's east of the divide and in the upper 80's in the west. Temperatures ranged from 75 at Butte to 90 at Thompson Falls (Bushey, 1989).

JULY 20 (Julian Date 202)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 49.3
Actual ERC for the day: no data
Seeley Lake Ranger Station; 3-day running mean ERC: 42.0
Actual ERC for the day: no data

The ERC at the Lincoln Ranger Station moves above the 80th percentile level (ERC = 49) as determined from the 1973-1987 seasons. This station would remain above this level until September 10th.

The ERC 90th percentile level (ERC = 41) is again reached at the Seeley Lake Ranger Station and levels above this point would be maintained until September 9th.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 8.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 13.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 16-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 16-4%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 15-6% at 5400 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 7-6%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 43-79
Monture 24 hr relative humidity range: 24-70%

Fire Behavior: Pushed by high winds the fire became active after being semi-dormant at less than 1/2 acre for 26 days (USDA Northern Region, 1989). Probability of Ignition increased during the afternoon burning period from 30% the previous day to 50% on this afternoon lasting until 2000 hrs. Estimated midflame wind speeds ranged during the afternoon from 0.2 - 4.0 MPH.

1747 hrs. "Winds blowing smoke to northeast, could be from North Fork Fire (Canyon Creek Fire)." (Aerial Patrol to Rocky Mountain Ranger District, Lewis and Clark National Forest, radio log.)

1750 hrs. "Can see smoke from fire on Lolo near Falls Point Lookout." (Silver King Lookout radio log.) [Note; Falls Point Lookout is an inactive tower approximately 3 1/4 miles southeast of the Canyon Creek Fire origin.]

Regional Weather: Clear skies, mild temperatures, and no precipitation easily describes the night over the Region. Overnight low temperatures were mostly in the 50's, and ranged from 34 at West Yellowstone to 56 at Billings. Skies remained clear through the day as the warm, dry, and stable airmass from the blocking high pressure persisted. Subsiding air was noted at high level weather stations which recorded low morning relative humidities. In western Montana and northern Idaho afternoon high temperatures were mostly in the mid to upper 90's, eastern Montana was in the 80's. Temperatures ranged from 85 at West Yellowstone, Glasgow, and Miles City to 98 at Grangeville and Thompson Falls. Some other hot temperatures from around the west included 95 degrees in Seattle; 110 in Medford, Oregon which was a new record for the date; and 118 in Redding, California tied the highest temperature ever recorded at that location (Bushey, 1989).

JULY 21 (Julian Date 203)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 52.0
Actual ERC for the day: 52
Seeley Lake Ranger Station; 3-day running mean ERC: 43.3
Actual ERC for the day: 44

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 7.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 13.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 12-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 13-3%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 12-3% at 5450 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4-3%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 43-91
Monture 24 hr relative humidity range: 13-70%
(Monture 1500 hrs readings; 83F, 20%)

Fire Behavior: The fire spotted to the east side of the Dry Fork of the North Fork of the Blackfoot River, covering the central portion of Section 11. Probability of Ignition on this date climbed to 80% during the afternoon. Estimated midflame wind speeds during the principal burning period ranged from 0.2-0.4 MPH. The combination of direct upslope winds on the west aspect across the Dry Fork, and lower afternoon fuel moistures contributed to the fire showing its first major increase in size. Fire behavior was limited to the burning of surface fuels, and the occasional torching of individual or small pockets of conifers. Digital mapping showed the burned acreage to be approximately 56 acres.

0600 hrs. "Can't see any smoke from Falls Point Lookout area, winds northwest 12-15 MPH, 54 degrees." (Silver King Lookout radio log.)

1140 hrs. Fire missed burning the drainage bottom riparian zone when it spotted to the northeast onto the southwest facing slope. The fire burned down to the riparian edge of still green sedges and willows. Fire active mostly on the east flank with some occasional torching to produce new spots, smoke color is white. Spot fires are widely scattered up to 1/8 mile from the main fire body. The fire was making small upslope runs in the timber with extensive areas of underburning. Smoke blowing northwest, off of the north and east flanks of the southwest facing slope. Small amount of smoke from the west flank drifting upslope. (Lolo National Forest video as interpreted by Bushey)

1152 hrs. Minor runs were occurring up the southwest facing slope but the fire was not crowning, strictly a surface fire at this time. (Lolo National Forest video as interpreted by Bushey)

1400 hrs. "Backcountry fire on Lolo putting up large column." (Silver King Lookout radio log.)

1600 hrs. "Lolo fire making huge run to south very large black column." (Silver King Lookout radio log.) [Note; huge is a relative term, here applied to the early season observations.]

1618 hrs. "Canyon Creek Fire has crossed Cabin Creek...not going any closer, wind is driving fire toward her (Kathy Heffernon, Wilderness Guard)." (Lolo National Forest, Fire Dispatch radio log.) [Note; fire was still in the Dry Fork drainage, not in the Cabin Creek drainage.]

1650 hrs. "State (Montana Department of State Lands) reported smoke near Ovando Mountain, may be Canyon Creek." (Lolo National Forest, Fire Dispatch radio log.)

1700 hrs. "Winds are picking up 25-32 MPH northwest." (Silver King Lookout radio log.)

1752 hrs. Fire is running to the north and east with thick white/gray smoke and a strong convection column. The column is laying on the slope above the fire and lifts off the slope approximately 2/3's of the distance up slope. Convection column breaks up as it clears the adjacent 6200 ft peaks to the northeast and begins to drift. Rest of the sky is clear with normal amounts of mountain forest haze. Spot fires are appearing on the north flank approximately 1/4 mile distance from the flank. Most of the burning is taking place on the east side of the Dry Fork, some activity is apparent on the west side. As the fire progressed upslope it would crown as pockets of fuel were encountered on both the north flank on the east side of the drainage and on the west flank on the west side of the drainage. Smoke was gray/black as areas of heavy fuel were burned. The west side of the drainage produced some crowning with runs to the ridgetop. (Lolo National Forest video as interpreted by Bushey)

1755 hrs. "There is definite black smoke. It rises white but then turns black. It is burning heavy fuel. The smokes have joined this afternoon." (Aerial observer on the Gates Park Wilderness Prescribed Fire describing the

Canyon Creek Fire in the distance to the Rocky Mountain District, Lewis and Clark National Forest; Rocky Mountain District radio log.) [Note; Gates Park Wilderness Prescribed Fire in the Bob Marshall Wilderness, approximately 49 miles north of the Silver King Lookout.]

1800 hrs. "Winds picking up northwest 27-35, smoke settling some still southern run." (Silver King Lookout radio log.)

1900 hrs. "Smoke is real heavy near Bowman Corner." (Rocky Mountain District, Lewis and Clark National Forest, radio log.) [Note; Bowman Corner is approximately 38 miles east of the Canyon Creek Fire origin and out on the plains.]

2112 hrs. "Smoke all north of Silver King, drifting east toward Great Falls area." (Silver King Lookout radio log.)

Weather Forecast: High pressure will weaken a little over the weekend, allowing a slight bit of cooling. Windy conditions, especially south and west aspects will persist most afternoons. Only slight risk of thunderstorms about Sunday. Major concern seems to be very low humidities. Recovery will be a little better in drainage bottoms over the weeekend, but slopes will continue quite poor with max RH's only in the 50-60% range.

For Friday
Weather...mostly clear
CWR...zero
Temperature...afternoon high 85-90
Humidity...Afternoon min 12% south aspect, 20% north aspect
Wind..eye level..Afternoon winds southeast / southwest 6-12, stronger on south aspects and over ridges.

(Missoula Fire Weather Office, Spot Forecast for Canyon Creek Fire, 1630 hrs. Thursday, July 21, 1988)

Regional Weather: The night brought continued clear skies and mild temperatures. Winds were light and generally less than 15 MPH. Morning low temperatures were mostly in the 50's, and ranged from 37 at West Yellowstone to 60 degrees at Miles City. The hot, dry airmass that was over Washington and Oregon was now over the Region with westerly winds. Afternoon temperatures were mostly in the 90's, and ranged from 89 at Wisdom to 100 in Billings. Missoula reached 96 which was the warmest day for the year (Bushey, 1989).

JULY 22 (Julian Date 204)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 54.6
Actual ERC for the day: 55
Seeley Lake Ranger Station; 3-day running mean ERC: 44.6
Actual ERC for the day: 44

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 6.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 13.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 11-3%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 8-2% at 5900 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 2%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 52-91
Monture 24 hr relative humidity range: 15-44%
(Monture 1500 hrs readings; 88F, 15%)

Fire Behavior: During the morning there were scattered spot fires still burning from the previous days fire run, no main column had as yet developed. Wind was light out of the west, then the smoke would swing down canyon to the southwest. Early afternoon behavior consisted of creeping and torching on the flanks with torching tree top flame lengths 1/2 again the tree heights. No evident spotting on the video (KECI-TV video). One Hr fuel moisture contents had dropped to two percent but winds were very light and upslope and down drainage. KECI's camera crew were disappointed because of the lack of more spectacular fire behavior, they returned to Missoula. Mick DeZell (FMO, Bitterroot National Forest) observed the selective nature of fire activity in the older, more decadent stands. He was asked to observe fire behavior and stand selection because of his experience with many prescribed fires in the Selway-Bitterroot Wilderness. He said the activity was what he would expect and the fire was doing fine.

An active upslope fire run took place on the eastside of the Dry Fork within Section 13 with an increase in late afternoon wind speed. Probability of Ignition increased to 100% with the low fuel moistures. A large convection column developing by 1500 hrs. By 1600 hrs the Canyon Creek Fire fire run was well established and the convection column would be visible from the Silver King Lookout. The convection plume was later observed by Byron Bonney and Norm Kamrud from the Gates Park Guard Station during the evening. The smoke from the Canyon Creek Fire would travel directly into Great Falls during the evening (Bonney, 1988). About 1700 hrs. Bailey flew the fire and could not see where it was located in the Dry Fork because of the smoke (USDA Northern Region, 1989). By 1900 hrs only scattered areas were still burning and the convection column had collapsed. The fire run lasted about 3 hrs, 1500-1800 hrs. The fire acreage was now estimated to cover about 1,300 acres (USDA Northern Region, 1989). Digital mapping later showed the burned acreage to be approximately 1,060 acres.

0700 hrs. "Hazey, no smoke from Canyon Creek Fire; 54 degrees, winds west 10-12 MPH." (Silver King Lookout radio log.)

1135 hrs. "Canyon Creek Fire kicking up somewhat south side." (Silver King Lookout radio log.)

1330 hrs. "Smoke volume increasing Canyon Fire." (Silver King Lookout radio log.)

1605 hrs. "Winds picking up west/northwest upper 20's lower 30's, 68 degrees. Smoke increasing to north area of Canyon Fire, some building cumulus to extreme south." (Silver King Lookout radio log.)

1615 hrs. "Large column occurring on Canyon Fire on northern edge." (Silver King Lookout radio log.)

1617 hrs. "Canyon Creek is visible from Stark." (Stark Mountain Lookout on the Ninemile Divide, approximately 76 miles west-southwest of the Canyon Creek Fire to the Lolo National Forest, Fire Dispatch radio log.)

1700 hrs. "Canyon Fire explodes to north, reminds me of pictures of Mt. St. Helens eruption." (Silver King Lookout radio log.)

1705 hrs. "... Lots of wind and air rough...Lolo side really rolling see column from here." (Aerial observer on Straight Creek Fire to Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1730 hrs. "Winds picking up hi 30's low 40's." (Silver King Lookout radio log.)

1750 hrs. "Blowup off southern edge of Canyon Fire, three columns now." (Silver King Lookout radio log.)

1800 hrs. "Winds increasing west / northwest 28-32 MPH, gusty into hi 30's. Southern edge of Canyon Fire now starting columns." (Silver King Lookout radio log.)

1900 hrs. "Winds decreasing upper 20's W. Blowup northern end. Smoke seen south-southwest Bugle Mountain could be Warren Creek Fire. Smoke column to north on Lewis and Clark, Straight Creek, 1300 acres." (Silver King Lookout radio log.)

2000 hrs. "Winds down upper teens." (Silver King Lookout radio log.)

Fire Weather: A small atmospheric disturbance passed over the fire caused the winds. A few high clouds were evident, but otherwise the sky was clear. Winds were light on the surface in the valleys, strong on the ridge tops. (Sisk interview)

Weather Forecast: Hot dry air mass over the area. Very weak frontal passage crossing fire area this evening will produce some wind but no clouds or moisture.

For the First Burn Period...Tonight
Weather...clear
CWR...zero
Temperature...lowest 50 to 55
Humidity...to 55%
Wind..eye level..south shifting to northwest 7 to 15 MPH this evening. Decreasing to light downslope late tonight 3 to 5 MPH.

For the Second Burning Period...Saturday
Weather...clear
CWR...zero
Temperature...80
Humidity...17%
Wind..eye level..upslope 3 to 8 MPH during the day..5 to 10 variable afternoon and evening

Outlook for Following Burn Period...Sunday and Monday warm and dry with moderate afternoon and evening winds 5 to 12 MPH.
(Missoula Fire Weather Office Spot Forecast for Canyon Creek Fire, 1334 hrs. July 22, 1988)

Regional Weather: Skies were generally clear across the Region during the night. Winds at most stations were light, less than 15 MPH, and southerly. Low overnight temperatures were in the low 50's to upper 60's, ranging from 41 at West Yellowstone to 68 at Miles City. Afternoon high temperatures were in the 90 to 105 degree range, from 82 in Mullan to 103 at Miles City. A Pacific cold front moving through southern Canada brought some afternoon clouds to the Glacier National Park area during the evening, creating some slightly stronger westerly winds in the northwest portion of the Region. This weather system pushed the high pressure further south allowing for some slightly cooler temperatures behind it. As the weak front moved east during the night the winds decreased behind it. A Red Flag Warning was issued by the National Weather Service for eastern Montana areas ahead of the front due to hot, windy weather (Bushey, 1989).

Miscellaneous: Straight Creek Fire on the Lewis and Clark National Forest discovered today (Bonney, 1988). The USFS Northern Region goes to Fire Preparedness Level 3 (Bushey, 1989).

JULY 23 (Julian Date 205)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 56.0
Actual ERC for the day: 58
Seeley Lake Ranger Station; 3-day running mean ERC: 46.6
Actual ERC for the day: 46

The Lincoln Ranger Station equals the ERC 90th percentile level as determined from the 1973-1987 seasons. This station would remain above this level until September 10th.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 6.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 12.6%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 12-3%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 8-4% at 5800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 12-4% at 6200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%
24 hr High-Low range, 1 Hr fuel: 13-4% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 54-89
Monture 24 hr relative humidity range: 16-48%
(Monture 1500 hrs readings; 88F, 19%)
(figures 48 - 49)

Fire Behavior: Canyon Creek Fire made a major run up Cabin Creek on the Lolo National Forest (Bonney, 1988). Fire behavior on this Friday was associated with strong winds. A Wilderness Ranger estimated the winds at Dry Fork Divide to be around 50 MPH at the start of the activity. The wind was picking up small rocks on the Divide and the observers were having a hard time keeping their hats tied down (Sisk interview). The fire burned toward Scapegoat Mountain, about 6.3 miles to the northeast. Fire run was of similar duration as on the previous day starting about 1430 hrs, peaking about 1700 hrs and having completed its run by 1900 hrs. The fire run was essentially up drainage, with the fire setting about mid-slope on the northwest flank with little spread, and traveling to the vegetated upper regions of Evans Peak and into Dobrota Creek at the base of Scapegoat Mountain. The crown fire run was calculated to have a rate-of-spread of approximately 1.0 - 2.6 miles per hour, with above crown flame lengths of about 60 - 160 feet, and a unit energy of 3,200 BTU/FT^2 75% confidence interval). This is within the estimated rate-of-spread for the crown fire run of 1.3 miles per hour (6.1 miles in 4.5 hours). The average calculated rate-of-spread would have ranged between 1.4 - 2.2 miles per hour, with a potential maximum of about 3.8 miles per hour for short periods of time (Rothermel, 1991)(figure 50). These conditions were achieved with an estimated average crown biomass of 5.0 tons per acre and surface fuel loads characteristic of Fuel Model 10, essentially no slope (the drainage was only about 20% which is insignificant to a crown fire) and wind speeds ranging between 24 to 34 MPH. These were locally strong winds not picked up by weather monitoring stations surrounding the wilderness. Some additional down drainage fire spread also occurred in the Dry Fork, allowing for another up slope run on the west facing aspect of a minor drainage to the south of Cabin Creek as well. Surface fuel moisture contents did not get as low as on previous days, only in to the 4% range, and Probability of Ignition ranged from only 80% at the lower elevations to 60% near timberline. The fire was a wind driven fire at the upper range of wind speed with a unit power of fire / unit power of wind ratio of about 0.37. The ratio must be above 1.0 for the fire to represent a blow-up fire powered by its own energy rather than the wind (Rothermel, 1991) which the ratio was at the lower end of the wind speed. Maximum spotting distance during the crown fire run would have been approximately 0.7 - 0.9 miles on the midslope windward side and from the ridgetop. Firebrands would have been tossed slightly less distance, 0.5 - 0.6 miles, from fire down in the Dry Fork drainage bottom.

Approximately 9,322 acres were burned on this date. The fire had burned about 10,326 acres in 48 hrs with a column visible from both Great Falls and Helena. Total within perimeter acreage was now about 10,382 acres. Estimated within perimeter acreage made right after the fire run was made was placed at 10,000 acres with approximately 4,000 acres of actual burned area inside the perimeter (USDA Northern Region, 1989). The Canyon Creek Fire became the largest wilderness prescribed fire to have burned in the entire Bob Marshall Wilderness complex.

0700 hrs. "Very smokey, winds north 5-10 MPH, 42 degrees. (Silver King Lookout radio log.)

Figure 48. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for July 23 - July 27, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

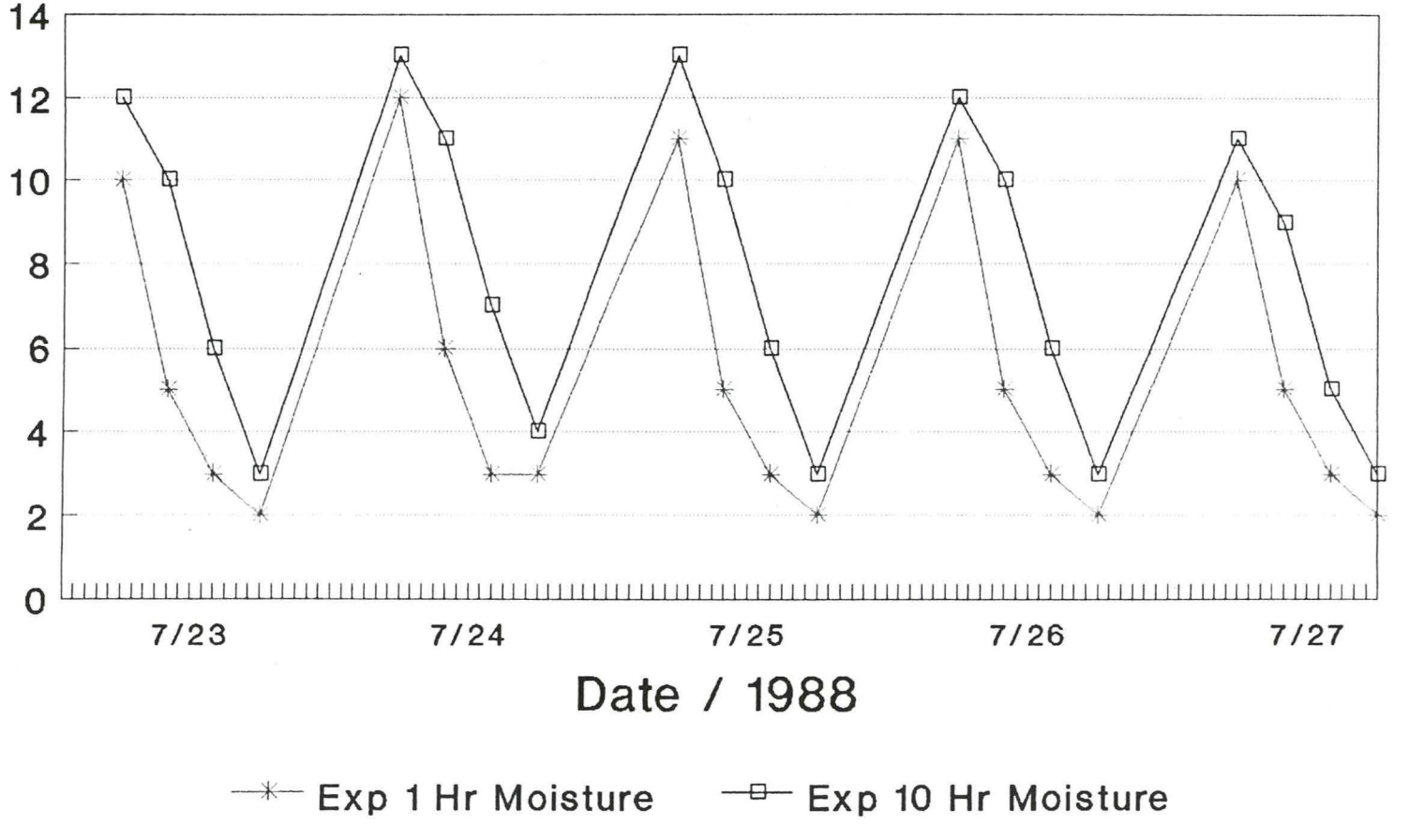


Figure 49. Monture RAWS Station air temperature and relative humidity measurements for July 23 - July 27, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

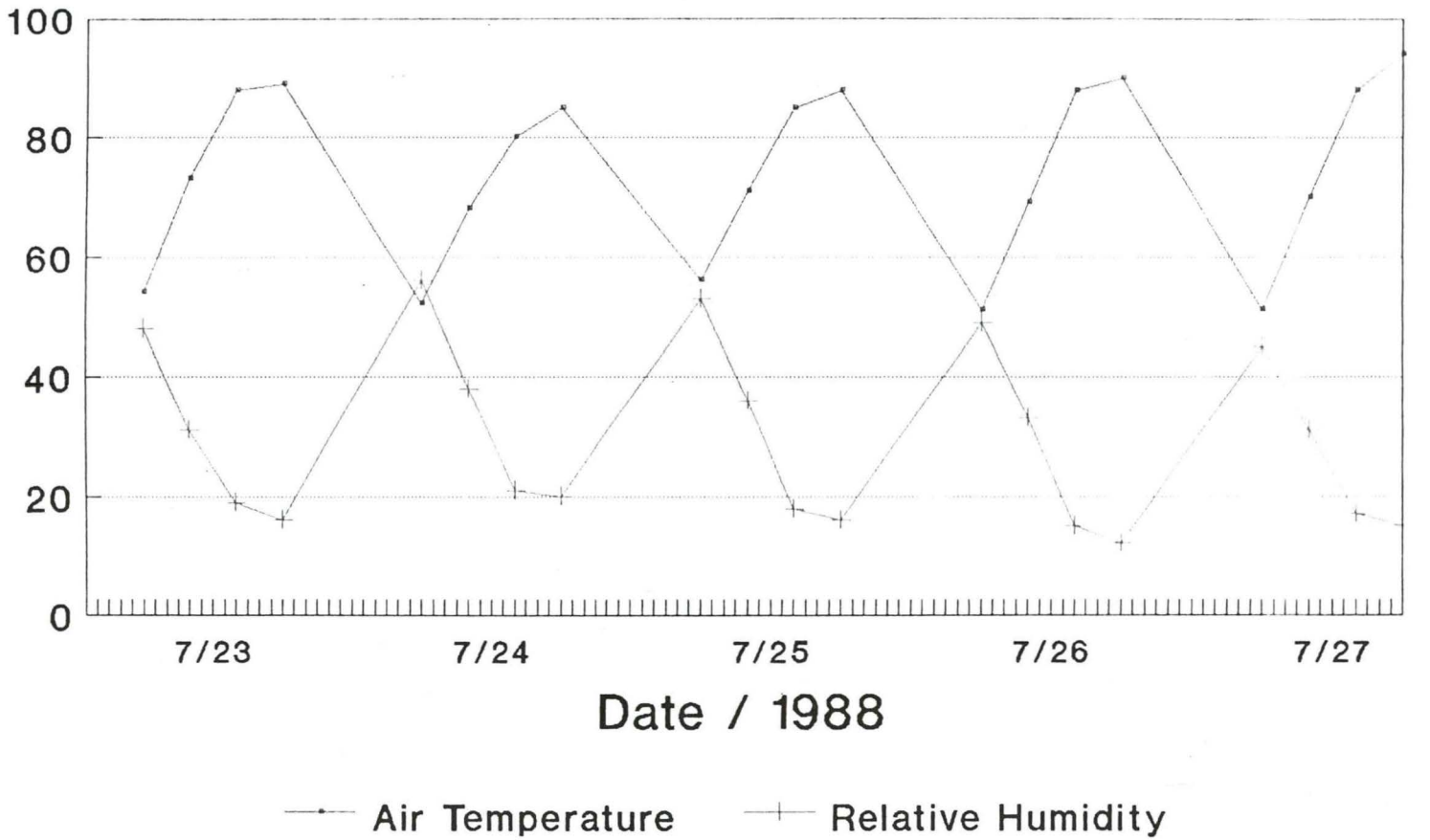
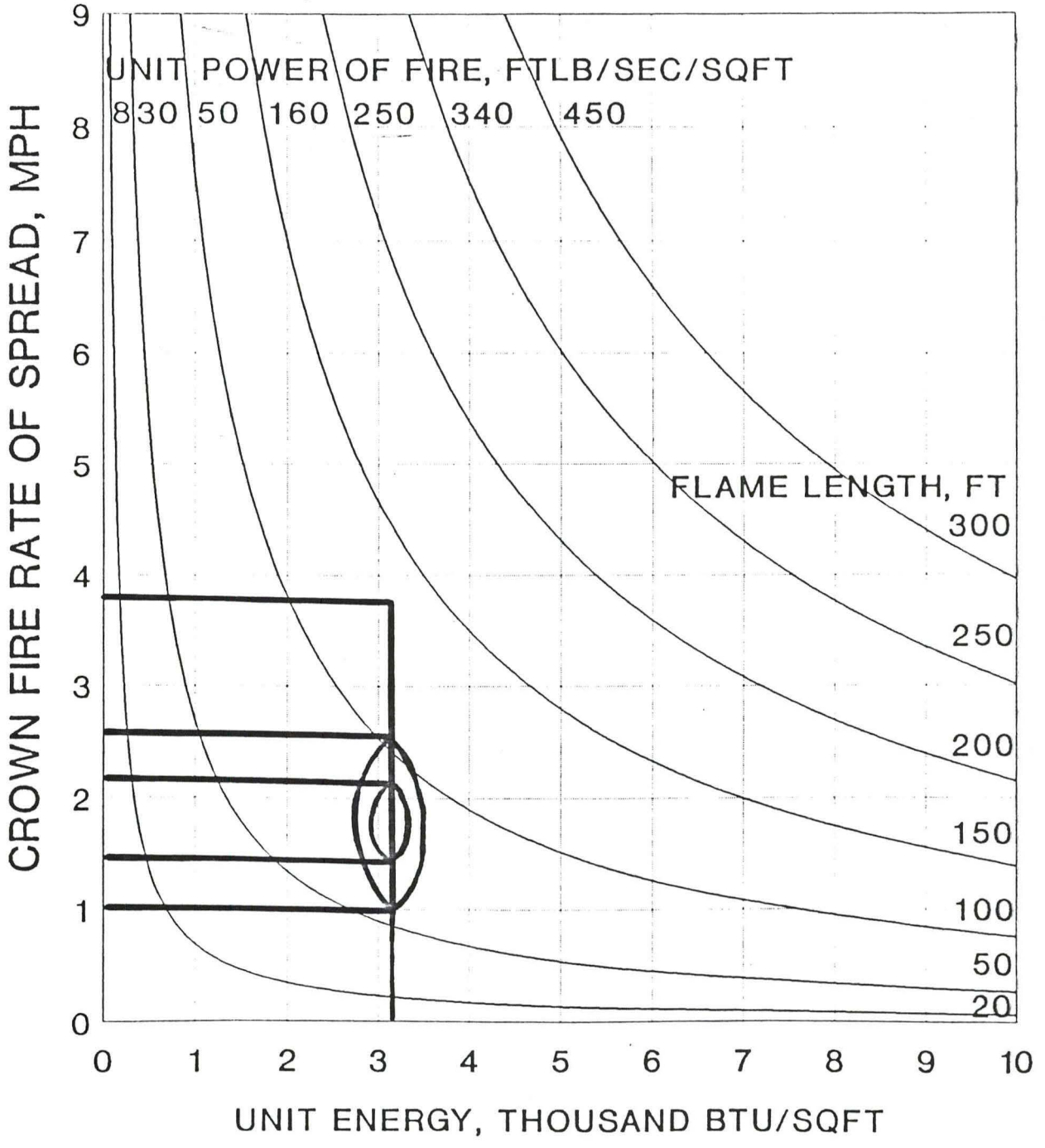


Figure 50. Detail from the Crown Fire Nomogram (Rothermel, 1991) for the July 23, 1988 fire behavior in the Cabin Creek drainage during the Canyon Creek Fire.


UNIT POWER OF FIRE, FTLB/SEC/SQFT
8 30 50 160 250 340 450
FLAME LENGTH, FT
300
250
200
150
100
50
20
CROWN FIRE RATE OF SPREAD, MPH
0 1 2 3 4 5 6 7 8 9
UNIT ENERGY, THOUSAND BTU/SQFT
0 1 2 3 4 5 6 7 8 9 10

0930 hrs. "Smoke is down on Canyon Fire." (Silver King Lookout radio log.)

1410 hrs. "Small column of smoke south side of Canyon Fire." (Silver King Lookout radio log.)

1435 hrs. "Large column now south side of Canyon Fire, 1 mile west of North Fork Falls as far north as Sarbo drainage." (Silver King Lookout radio log.)

1500 hrs. "Winds picking up out of south 10-15 MPH." (Silver King Lookout radio log.)

1700 hrs. "Canyon Fire smoking up back country, staying low in valley bottoms." (Silver King Lookout radio log.)

Regional Weather: Skies were generally fair to partly cloudy over the Region during the night. The exception was southcentral Montana where scattered shower and thunderstorm activity took place. Temperatures overnight dropped into the 50's and 60's, and ranged from 44 at West Yellowstone to 65 at Miles City. The National Weather Service continued Red Flag Warnings in eastern Montana, Wyoming, and Colorado for dry, gusty winds associated with the cold front passage. "Near Red Flag conditions" were present west of the continental divide due to a combination of low fuel moistures, continued low humidities, and moderate wind or thunderstorms. In the afternoon it was mostly sunny with light winds in the west, and partly cloudy in the east. High pressure rebounding after the frontal passage produced some easterly winds along the Rocky Mountain Front Range. Visibility in the southwestern portion of Montana was reported to be reduced by smoke from fires. Afternoon temperatures were cooler following the frontal passage and were in the 80's and lower 90's. Livingston and Lewistown had the coolest afternoon high temperatures at 79, Thompson Falls was the warm spot with 95. A subsiding airmass with very low humidities caused mid and high elevations to experience extremely poor nighttime humidity recovery (30-40% maximum). A very dry airmass continued over northern California, Oregon, southern Idaho, eastern Montana, and western South Dakota (Bushey, 1989).

Long-Range Weather Forecast: The three to five day weather forecast kept the Region very warm and dry with the possibility of some upper level moisture arriving the 26th or 27th which could act as a trigger for some more dry lightning. Six to ten day forecast continued to indicate above normal temperatures with no precipitation (Bushey, 1989).

Miscellaneous: The Palmer Drought Severity Index issued on this date indicated that all areas in the Region east of the continental divide and most of the Northern Rocky Mountains were in the extreme drought category except for an area of severe drought in the southcentral portion of the Region. Moving west, very narrow north-south bands of increasingly more moist conditions existed with most of northern Idaho being labeled as moist (Bushey, 1989).

The Regional Incident Coordinating Organization (RICO) was mobilized in the Northern Region at the Aerial Fire Depot in Missoula. The USFS Northern Region also went to Fire Preparedness Level 4, only 24 hours after declaring Level 3 (Bushey, 1989).

JULY 24 (Julian Date 206)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 57.0
Actual ERC for the day: 57
Seeley Lake Ranger Station; 3-day running mean ERC: 47.3
Actual ERC for the day: 46

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 6.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 12.3%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 12-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 13-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 17-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 24-7%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 10-4% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%
24 hr High-Low range, 1 Hr fuel: 11-5% at 6000 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 52-85
Monture 24 hr relative humidity range: 20-56%
(Monture 1500 hrs readings; 80F, 21%)
Benchmark 24 hr temperature range (degrees F): 49-83
Benchmark 24 hr relative humidity range: 19-80%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-13
(Benchmark 1346 hr readings; 82F, 19%, 13 MPH)
(figures 51 - 52)

Fire Behavior: Principal fire spread again returned to southeasterly down the Dry Fork of the North Fork of the Blackfoot River with minor crown fire runs up the adjacent lower slopes of both Falls Point and Lake Mountain. These later runs were the result of late afternoon heating and the resultant increase in upslope winds. Probability of Ignition range from 70% in the lower drainage bottom to 60% at the higher elevation of this days fire runs. An additional 416 acres were included within the fire perimeter bring the total fire acreage to approximately 10,798.

1100 hrs. "Blanket smoke drifting in bottoms thru out back country." (Silver King Lookout radio log.)

1400 hrs. "Column smoke now visible south side of Canyon Fire." (Silver King Lookout radio log.)

1640 hrs. "Back country almost completely obscured by smoke. West, northwest and north are very smokey. Winds southwest 10-12 MPH." (Silver King Lookout radio log.)

1800 hrs. "Smoke so thick can't see back country, visibility poor every where else." (Silver King Lookout radio log.)

Figure 51. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, and average wind speed measurements for July 24 - July 27, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)

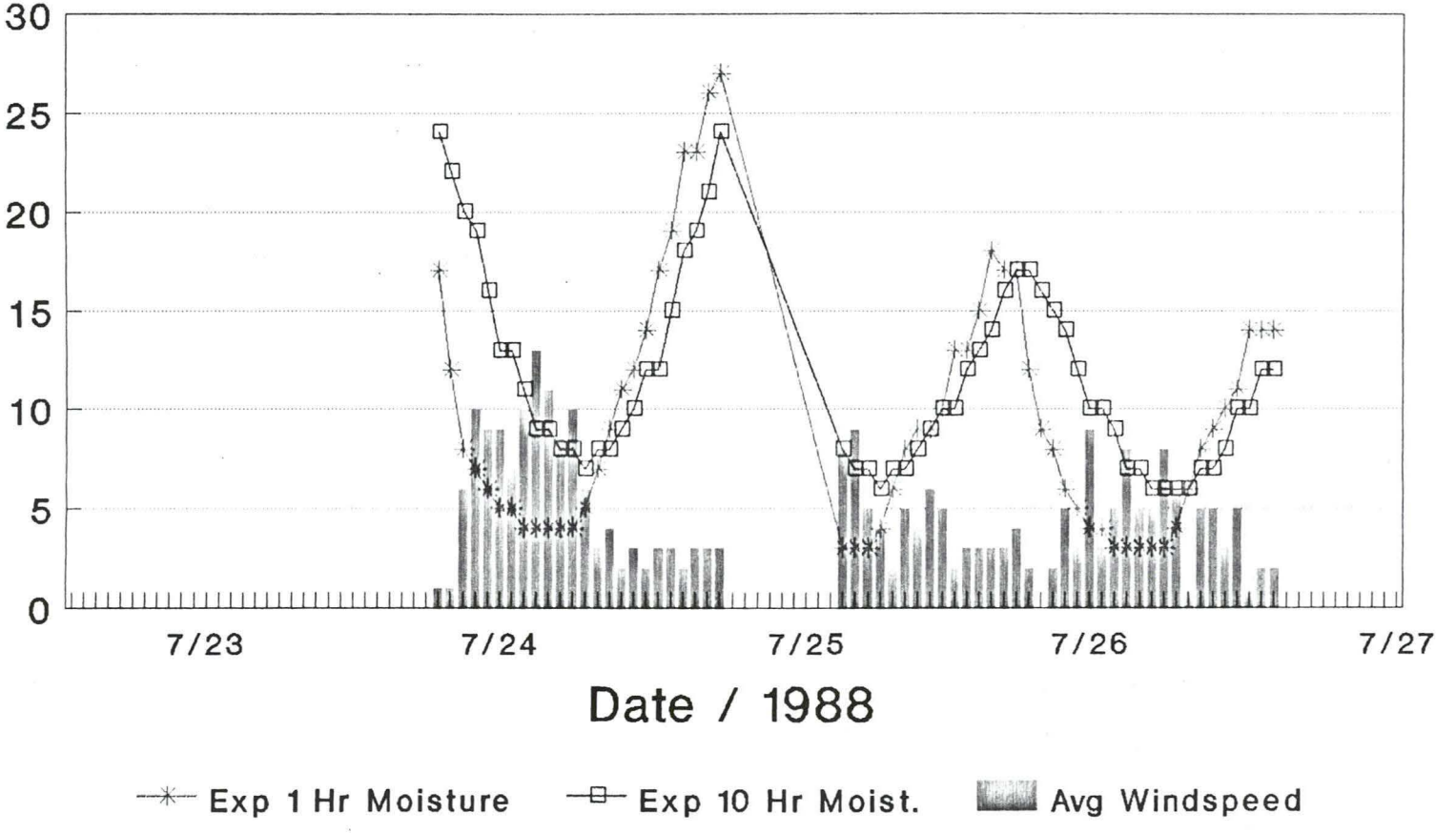
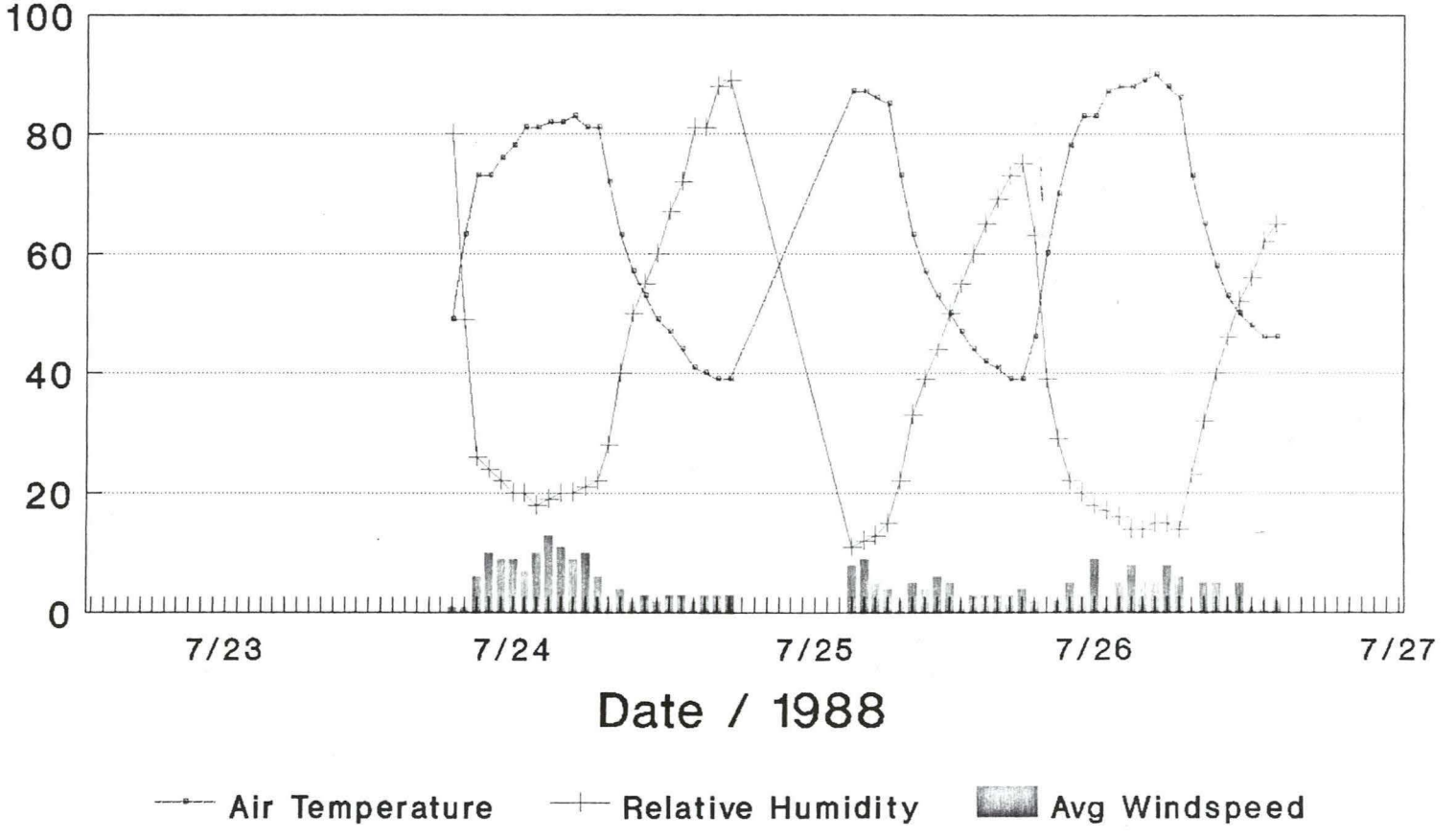


Figure 52. Benchmark RAWS Station air temperature and relative humidity, and average wind speed measurements for July 24 - July 27, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)



1900 hrs. "Smoke worsening, can't see Lone Mountain (white out) southwest - west - northwest - north - northeast very poor elsewhere. Winds northwest 17-22 mph." (Silver King Lookout radio log.) [Note; Lone Mountain is approximately 4 miles west of Silver King Lookout.]

1950 hrs. "Winds picking up blowing smoke out, still can't see any column. Winds west 22-26 mph." (Silver King Lookout radio log.)

Regional Weather: Night and early morning skies were partly cloudy across the Region with the remnants of a little moisture which moved through during the night. Morning low temperatures ranged from 40 at West Yellowstone to 60 at Polson, with most temperatures in the mid to upper 50's. Afternoon temperatures were slightly higher than the previous day with most stations in the low 90's, and ranging from 85 at Butte and Mullan to 97 at Thompson Falls. Very strong high pressure continued over the Region producing the above normal temperatures and low humidities and was expected to remain in place for the next two to four days.

Long-Range Weather Forecast: Three to five day forecast indicated an increasing risk of thunderstorms over most of the western half of the Region. A Pacific weather front was expected to bring west winds but no rain (Bushey, 1989).

JULY 25 (Julian Date 207)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 57.6
Actual ERC for the day: 59
Seeley Lake Ranger Station; 3-day running mean ERC: 47.3
Actual ERC for the day: 47

The ERC 97th percentile level (ERC = 47) is reached at the Seeley Lake Ranger Station. ERC levels at this station would remain above this level for eleven days before starting to drop.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 6.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 12.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.6%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 11-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 13-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-35
Benchmark, 24 hr High-Low range, 10 Hr fuel: 24-6%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 10-3% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4-3%
24 hr High-Low range, 1 Hr fuel: 11-4% at 6400 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 56-88
Monture 24 hr relative humidity range: 16-53%
(Monture 1500 hrs readings; 85F, 18%)
Benchmark 24 hr temperature range (degrees F): 39-87
Benchmark 24 hr relative humidity range: 11-89%
Benchmark 24 hr average 20 ft wind speed range (MPH): 3-9
(Benchmark 1646 hr readings; 87F, 11%, 8 MPH)

Fire Behavior: Fire spread continued to the southeast down the Dry Fork of the North Fork of the Blackfoot River. Spread was on both sides of the drainage with the majority of the fire burning on the west and south flanks of Falls Point Mountain. Fire in this area made a small run with some spotting toward the top of Falls Point, burning around the upper elevations on the east and north aspects and reaching the base of the lookout on the ridge top. The fire also encountered the western edge of the 1952 North Fork Fire perimeter at which point spread essentially stopped for the burning period. Probability of Ignition ranged from 80% at the lower elevations along the Dry Fork to 70% around the upper extends of the day's burning. Estimated acreage of the fire was expanded to 12,000 (USDA Northern Region, 1989). Digitized acreage showed that about 960 acres were burned on this date bringing the actual within perimeter fire acreage to 11,758.

1320 hrs. "Column seen south side of Canyon Fire." (Silver King Lookout radio log.)

1500 hrs. "White out southwest - west -northwest - north - northeast, poor elsewhere." (Silver King Lookout radio log.)

1515 hrs. "Socked in." (Silver King Lookout radio log.)

1625 hrs. "Smoke lifting west - southwest -northwest." (Silver King Lookout radio log.)

1645 hrs. Large plume now visibly south side Canyon Fire." (Silver King Lookout radio log.)

1745 hrs. "I've got falling ash the size of dimes north - west of Silver King." (Silver King Lookout radio log.)

1840 hrs. Winds west 14-16 MPH. Vertical column 1200-1400 ft., smoke black-coppery. Ash still falling, not as large. Stings the eyes. Very active." (Silver King Lookout radio log.)

2000 hrs. "Fire still very active. Possible smoke west slope Bugle Mountain. Wind change northwest 18-20 MPH." (Silver King Lookout radio log.)

2015 hrs. "Smoke starting to drift in valley bottoms." (Silver King Lookout radio log.)

2030 hrs. "Can't see column anymore for drift smoke density." (Silver King Lookout radio log.)

2200 hrs. "Socked in, can't see any of my nite landmarks." (Silver King Lookout radio log.)

Weather Forecast: High pressure over the area for hot dry conditions today and Tuesday with light winds. Pacific weather front moving in from the west late Tuesday night and early Wednesday bringing winds to the fire area followed by a little cooler weather Thursday.

For the First Burn Period...TODAY
Weather...clear
CWR...zero
Temperature...highest 88
Humidity...lowest 15%
Wind..eye level..light and variable mostly slope winds 3 to 7 MPH

For the Second Burning Period...TONIGHT
Weather...clear to few high clouds
CWR...zero
Temperature...lowest 49
Humidity...recovery to only 55% on the slope
Wind..eye level..downslope 2 to 5 MPH

Outlook for Following Burn Period...South winds developing late Tuesday and Tuesday night followed by gusty northwest winds during the day Wednesday with partly cloudy skies, continued dry with temperatures down 10 degrees Thursday with upper 70s low 80's Friday and Saturday under sunny skies.
(Missoula Fire Weather Office Spot Forecast For the Canyon Creek Fire, 1130 hrs. Monday July 25, 1988)

Regional Weather: Except for some scattered high clouds skies across the Region were clear through the night. Winds at most stations were light and less than 15 MPH. Overnight temperatures were in the 50's and 60's, and ranged from 43 at West Yellowstone and Drummond to 66 at Miles City. The large, high pressure system continued to give the Region hot, dry weather as afternoon temperatures rose into the 90's. High temperatures ranged from 89 at Butte and Mullan to 101 at Thompson Falls. In Missoula this was the seventh day in the 90's. In Washington record high temperatures were set in Settle and Olympia. Seattle reached 94 degrees and Spokane 97. Lewiston, Idaho reached 102 degrees. Humidities in the Region ranged from 10 to 20%. Nighttime inversions caused midslope thermal belts and smokey valleys.

A Pacific front was being tracked as it approached the west coast of Canada. Most of the precipitation with this front was expected to fall over Canada, bring only shifting winds and some cloudiness to the Region. A chance of dry lightning was projected along with slightly cooler afternoon temperatures, back to nearer seasonal 80's (Bushey, 1988).

JULY 26 (Julian Date 208)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 59.0
Actual ERC for the day: 60
Seeley Lake Ranger Station; 3-day running mean ERC: 47.6
Actual ERC for the day: 45

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 6.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 12.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 11-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 12-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 18-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 17-6%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 9-3% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 3%
24 hr High-Low range, 1 Hr fuel: 11-4% at 6500 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 51-90
Monture 24 hr relative humidity range: 12-49%
(Monture 1500 hrs readings; 88F, 15%)
Benchmark 24 hr temperature range (degrees F): 39-90
Benchmark 24 hr relative humidity range: 14-75%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-8
(Benchmark 1346 hr readings; 88F, 14%, 8 MPH)

Fire Behavior: The fire increased by 4,413 acres (16,170 total within perimeter acres) and moved onto the Helena National Forest through the East Fork of the North Fork of the Blackfoot River. It burned over most of Section 29 and was active near the North Fork Cabin (USDA Northern Region, 1989). The fire initially moved to the southeast down the Dry Fork. About 1500 hrs the fire was approximately 1/8 mile from the junction of the Dry Fork and the North Fork of the Blackfoot River and moving mostly on the valley floor toward the North Fork Cabin and the south and west facing aspects of Falls Point. At this location the fire behavior started to increase significantly and the fire started a crown fire run east toward the junctions of the East and North Forks of the Blackfoot River. Principal fire spread was to the east with hooking upslope runs on the north (Falls Point Mountain) through the 1952 North Fork Fire, and south (northern portions of Mineral Hill) flanks as the fire moved through the drainage junction. The fire run picked up after 1500 hrs, peaked about 1700 hrs and the convection column was sagging and the run essentially finished by 1900 hrs. During this time period, spots fires which had been placed over the ridges on the north and southeast flanks of Evans Peak on July 23rd burned downslope within Broadus, Eagle and Dobrota Creeks pushed by winds out of the west. This would be the furthest extend of the fire to the north and east of Evans Peak and between Scapegoat Mountain. Also, fire which had been sitting midslope on the southeast facing aspect of Cabin Creek and to the northeast of the fire origin on the west aspect of the slope above the Dry Fork

made upslope and up drainage runs to the rocky ridge top further completing the burnout of the Cabin Creek drainage. This last area of the fire perimeter would remain inactive for the next 29 days. Probability of Ignition on this day was 70% over the elevational range of the fire.

0600 hrs. "Smoke laid down, much denser and darker than it has been in past days. Expecting earlier activity on fire. Valley bottoms thru out viewing area smoke filled." (Silver King Lookout radio log.)

0700 hrs. "Drift smoke lifting." (Silver King Lookout radio log.)

0800 hrs. "Drift smoke left with exception of Blackfoot Valley. Winds northwest 10 MPH." (Silver King Lookout radio log.)

1000 hrs. "Winds west 8-12 MPH. Blanket smoke obscuring view of Canyon Fire." (Silver King Lookout radio log.)

1230 hrs. "Activity starting on south side Canyon Fire. Winds west / southwest 8-10 MPH." (Silver King Lookout radio log.)

1330 hrs. "Large column smoke rising off of Canyon Fire. Winds west / southwest 10-15 MPH." (Silver King Lookout radio log.)

1400 hrs. "Winds picking up southwest 18-22 MPH." (Silver King Lookout radio log.)

1437 hrs. "Huge blowup occurring on Canyon Fire. Much larger than yesterdays plume must be 2000-2500 ft or more and growing (building cumulus to my south). Winds southwest upper teens-low 20's." (Silver King Lookout radio log.) [Note; the height was mostly likely abbreviated and should have read 20,000 - 25,000 ft.]

1530 hrs. "Can see flames north ridge Mineral Mountain." (Silver King Lookout radio log.)

1629 hrs. "Only active spot is on east side where original fire started. Southwest corner crossed North Fork of the Blackfoot burning east up East Fork Creek. North Fork Cabin looks fine. It has burnt all the way around it. Fire burnt onto Helena (National Forest) in Section 34 where Camp Creek comes into East Fork Creek." (Lolo National Forest, Fire Dispatch radio log.)

1650 hrs. "Wind change west / northwest 8-10 MPH." (Silver King Lookout radio log.)

1657 hrs. "Fire now on Helena (National Forest)." (Silver King Lookout radio log.)

1715 hrs. "Another blowup on fire. Winds west 10-14 MPH." (Silver King Lookout radio log.)

1930 hrs. "Can see flames racing up Mineral Mountain. Burning up and down east slope Mineral Mountain toward East Fork Blackfoot. Wind west 6-10 MPH." (Silver King Lookout radio log.)

2050 hrs. "Fire setting down. Winds calm." (Silver King Lookout radio log.)

2200 hrs. "Smoke filling valley bottoms." (Silver King Lookout radio log.)

Regional Weather: Skies were clear except for a few high clouds during the night. Overnight low temperatures were in the 50's and 60's, and ranged from 41 at Drummond to 64 in Billings. Afternoon high temperatures were in the 90's, ranging from 87 at West Yellowstone to 104 at Broadus. For the past seven days temperatures in Missoula had been in the 90's with low humidity. This day was the warmest day yet of the year with 97 degrees. Miles City recorded 103 degrees, Billings 99, and by mid-afternoon West Yellowstone had 87. By late afternoon thunderstorms had built up south of the Salmon River. An upper level trough of low pressure was entering the Region from the west during the night. A Red Flag Watch was issued by the National Weather Service for the western portions of the Region for dry lightning and gusty winds associated with the atmospheric disturbance (Bushey, 1989).

JULY 27 (Julian Date 209)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 60.0
Actual ERC for the day: 61
Seeley Lake Ranger Station; 3-day running mean ERC: 48.3
Actual ERC for the day: 48

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 6.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.6%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 11-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 14%-no data
Benchmark, 24 hr High-Low range, 10 Hr fuel: 13%-no data

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 9-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 11-4% at 7600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 51-94
Monture 24 hr relative humidity range: 17-47%
(Monture 1500 hrs readings; 88F, 17%)
Benchmark 24 hr temperature range (degrees F): no data
Benchmark 24 hr relative humidity range: no data
Benchmark 24 hr average 20 ft wind speed range (MPH):nodata
(Benchmark 1346 hr readings; no data)

Fire Behavior: The fire was burning very active along the ridge about 2 1/2 miles north of Mineral Hill down toward the North Fork Cabin and in the high basin on the east side of the ridge on the Helena National Forest side. The fire also spotted to the southeast across the ridge into Camp Creek on the Lincoln Ranger District but was not burning actively in that location, just smoking up. The Cabin Fire that burned in 1979 kept the Canyon Fire from traveling any further up the East Fork of the North Fork of the Blackfoot River due to sparse fuels (Bonney, 1988). Acreage was estimated at 13,000 at the time (USDA Northern Region, 1989). Digitized data would later show the fire to have covered an additional 1,173 acres on this date bringing the total within perimeter fire acres to 17,343. Fire spread during this time period was principally to the southeast on the north and northeast flanks of Mineral Hill. This was the only portion of the fire which was active on this date. The Probability of Ignition during the peak burning hours on this day was 70% over the elevational range of the fire. The Canyon Creek Fire was reported to have a wind sheared convection column but did not make any impressive fire runs as did the Gates Park Fire to the north (Bushey, 1989)(see Miscellaneous below). The increased activity on the Gates Park Fire, the sheared convection column over the Canyon Creek Fire, and increased and erratic fire behavior on the Madison Gulch Fire west of Missoula may have been due to the presence of a reverse wind profile indicated by the radiosonde readings from Spokane, Washington. A RICO fire Behavior Service Center warning had been issued for the potential of increase fire behavior associated with this wind phenomena.

0500 hrs. "Wind northwest 16-22 MPH. Cloud cover over Blackfoot Valley, lite rain not reaching ground." (Silver King Lookout radio log.)

0800 hrs. "Drift smoke filling valley bottoms." (Silver King Lookout radio log.)

1100 hrs. "Winds west 18-22 MPH, DB 63, WB 47, RH 30/31. Visibility poor in valley bottoms." (Silver King Lookout radio log.)

1140 hrs. "Column smoke seen on Canyon Fire south side. Winds west 10-12 MPH." (Silver King Lookout radio log.)

1200 hrs. "WB 49, DB 67, RH 27, winds west 20-24 MPH. Good sized column of smoke, can see flames." (Silver King Lookout radio log.)

1215 hrs. "Column now 1000 ft estimated, gray colored. Blackfoot Valley poor visibility. Ridges and mountains above 6500 ft are clear." (Silver King Lookout radio log.)

1230 hrs. "Winds picking up west / northwest upper 20-low 30's. Plume now estimated at 1200 feet." (Silver King Lookout radio log.)

1300-2000 hrs. Winds continued to blow out of the west mostly 20-28 MPH with gusts recorded up to 38 MPH, humidities dropped to 18% between 1500-1800 hrs. then started to rise again. Notes from Silver King Lookout radio log.

2030 hrs. "Can see flames on north slope Bugle Mountain." [Note; actually on Mineral Mountain.] (Silver King Lookout radio log.)

2150 hrs. "Sections 11 and 12, 1/2 up mountain burning actively." [Note; actually Sections 9 and 10 further west on Mineral Mountain.] (Silver King Lookout radio log.)

2200 hrs. "DB 62, WB 46, RH 29, winds erratic west / northwest 35-38 MPH gusting in low 40's. Can see flames." (Silver King Lookout radio log.)

2300 hrs.. "Fire on Bugle Mountain (Mineral Mountain) very active can see glare from west slope almost to the mountain top. The progress of the north slope slowing some, but I expect to see the entire mountain burned by morning. Winds erratic west / northwest low to upper 30's gusting to 42 MPH, DB 60, WB 45, RH 31. Going to bed." (Silver King Lookout radio log.)

Weather Forecast: Hot dry air mass late today with high level instability. A weak pacific weather front is moving in from the northwest this evening could trigger some dry lightning thunderstorms this evening with clearing from the west later tonight. Wnds southerly today shifting to north tonight and Thursday.

For this Evening and Tonight...
Weather...Red Flag Warning...Threat of isolated thunderstorms in the area causing erratic gusty winds. Clearing later tonight.
CWR...below 20%
Temperature...low tonight 50
Humidity...Recovery to 60%
Wind..eye level..erratic and gusty...very gusty if near thunderstorm anywhere near fire area. Winds generally shifting to northwest 10 to 20 tonight.

Thursday...
Weather...sunny
CWR...below 10%
Temperature...82
Humidity...20%
Wind..eye level..Northwest 10 to 20 afternnon and evening decreasing to light Thursday night.

Outlook Friday into the Week...Sunny warm dry days with afternoons in upper 80's again this weekend. Humidity afternoon is 15 to 20% with poor recovery at night to only 55%. Winds light night and morning coming up 5 to 15 late afternoon and evenings.
(Missoula Fire Weather Office Spot Forecast For Canyon Creek Fire, 1300 hrs. Wednesday, July 27, 1988)

Regional Weather: A weakening trough of low pressure which was pushing inland from the Pacific Northwest coast was maintaining a flow of moist air from the southwest into central Idaho, and south and west Montana. The moisture resulted in some clouds and a few light showers early in the morning. Morning low temperatures were mostly in the 50's and 60's across the Region, and ranged from 48 at Libby to 77 at Miles City. The front moved across the Region during the afternoon and was considerably weaker than expected in terms of convective activity. The National Weather Service posted Red Flag Warnings in eastern Montana for dry lightning and gusty winds associate with the passage of this front. It brought wind to all of western Montana and portions of northern Idaho. Livingston had wind gusts to 47 MPH during the afternoon from a nearby

thunderstorm. Winds in the western valleys of Montana were in the 15 to 25 MPH range. Lightning was confined to the southern fringe of the Region from the Nez Perce National Forest eastward through the Custer National Forest. Afternoon skies were partly cloudy to cloudy, with visibility additionally reduced by smoke in the southwestern portions of Montana. Afternoon high temperatures were mostly in the 90's, and the 80's in the southwest; ranging from 82 at West Yellowstone to 105 at Broadus. Thunderstorm activity in the southern portions of Yellowstone National Park was heavy by 1700 hrs (Bushey, 1989).

Long-Range Weather Forecast: Weather Bank issued their August forecast for the Missoula-Seeley Lake Fire Zone. It indicated "a little above normal temperatures and below normal precipitation for the Canyon Creek Area." Although predicting a few occasional thundershowers, it doubted significant frontal activity would occur and said hot, dry spells were possible. The forecast said that the NWS predicted below normal temperatures and near or slightly above normal precipitation for late summer into fall. (USDA Northern Region, 1989)

Miscellaneous: Gates Park Wilderness Prescribed Fire made a major run up Ray Creek towards Old Baldy Mountain. This fire spotted outside the wilderness boundary to the east of Hidden (Our) Lake. This was a spotting distance of about 3/4 of a mile. It is believed that the fire spotted this far because the convection column did not gain much elevation, as it was sheared off by the wind. This caused the embers to be dropped prematurely rather than being carried aloft and not becoming a problem to long range spotting. (Bonny, Gates Park Prescribed Fire, Fire Behavior Narrative) The run on this day increased the fires perimeter acreage by approximately 2,000 acres. This fire was producing a radar echo in Missoula with a 20,000' convection column during the afternoon. The plume was continuous for at least 25 miles tothe east and was dropping ash in Choteau, Montana. The fire made two, two mile pulses in a run up Ray Creek drainage on the west side of the Continental Divide. Each wind driven run was less than a mile in width. Two spot fires were caused by firebrands thrown over the rock wall of the Continental Divide in the vicinity of Our Lake outside of the wilderness boundary (Bushey, 1989).

JULY 28 (Julian Date 210)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 61.0
Actual ERC for the day: 61
Seeley Lake Ranger Station; 3-day running mean ERC: 48.3
Actual ERC for the day: 48

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 6.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.3%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 9-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 10-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel:
Benchmark, 24 hr High-Low range, 10 Hr fuel:

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 9-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 11-4% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 58-88
Monture 24 hr relative humidity range: 16-43%
(Monture 1500 hrs readings; 88F, 17%)
Benchmark 24 hr temperature range (degrees F): no data
Benchmark 24 hr relative humidity range: no data
Benchmark 24 hr average 20 ft wind speed range (MPH):nodata
(Benchmark 1346 hr readings; no data)
(figures 53 - 56)

Fire Behavior: Fire spread was up drainage, to the northeast, in relation to the North Fork of the Blackfoot River with the majority of the burned acreage resulting from short upslope fire runs and short distance spotting. The fire also continued to burn upslope on Mineral Hill on the northeast and northwest flanks. Additional spread was also observed from upslope fire on the northeast flank of the mountain ridge to the south of the Dry Fork of the North Fork of the Blackfoot River. Some additional fire spread was also recorded in Broadus Creek on the east flank of Evans Peak as the fire there continued to back downslope, this fire evidently spotted across on to the west aspect across Broadus and Eagle Creeks where underburning and small crown fire runs occurred. Probability of Ignition during the peak burning hours ranged from 60 to 70%. The fire covered about 2,089 acres during the burning period bringing the within perimeter fire acreage to 19,432 acres.

0700 hrs. "DB 53, WB 40, RH 32; winds very strong, erratic west / northwest Not much activity on fire, 3/4's burned to top of Bugle (Mineral) Mountain." (Silver King Lookout radio log.)

0800 hrs. "DB 52, WB 40, RH 35; winds strong, erratic west / northwest 26-28 MPH, gusting 30-34. Little activity on fire." (Silver King Lookout radio log.)

1105 hrs. "DB 54, WB 42, RH 37; winds west 24-26." [Lookout note; "Highest humidity" for the day.] (Silver King Lookout radio log.)

1130 hrs. "Fire activity starting on upper 1/3 of ridge." (Silver King Lookout radio log.)

1200 hrs. "DB 58, WB 44, RH 33; winds west / northwest 28-30 MPH." (Silver King Lookout radio log.)

1205 hrs. "Column just starting." (Silver King Lookout radio log.)

1300 hrs. "DB 64, WB 45, RH 21; winds W 26-28." (Silver King Lookout radio log.)

1500 hrs. "DB 65, WB 47, RH 25, winds 24-28 MPH. Fire making a run across northeast slope, putting up a good sized column drifting to the northeast." (Silver King Lookout radio log.)

Figure 53. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for July 28 - August 1, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

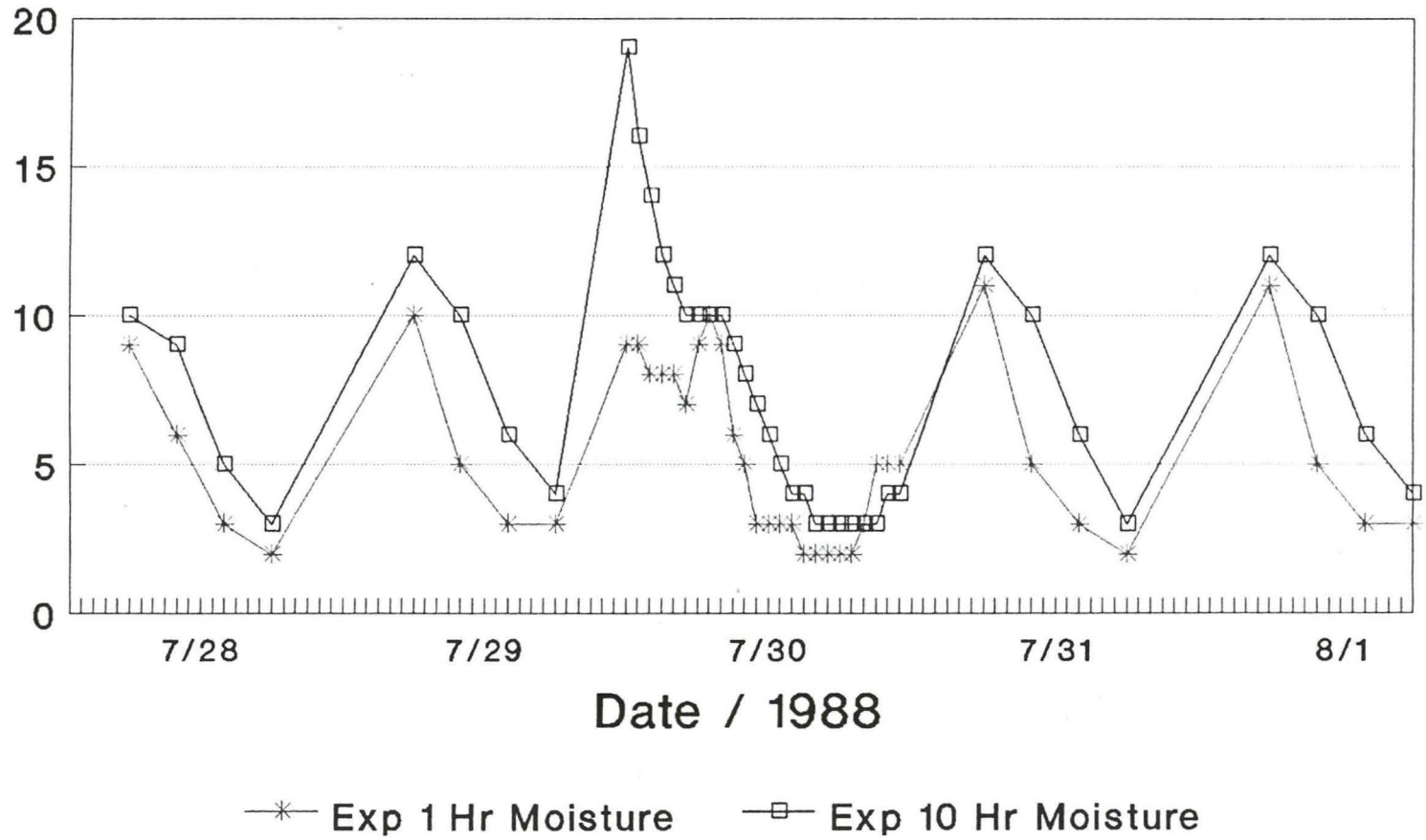


Figure 54. Monture RAWS Station air temperature and relative humidity measurements for July 28 - August 1, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

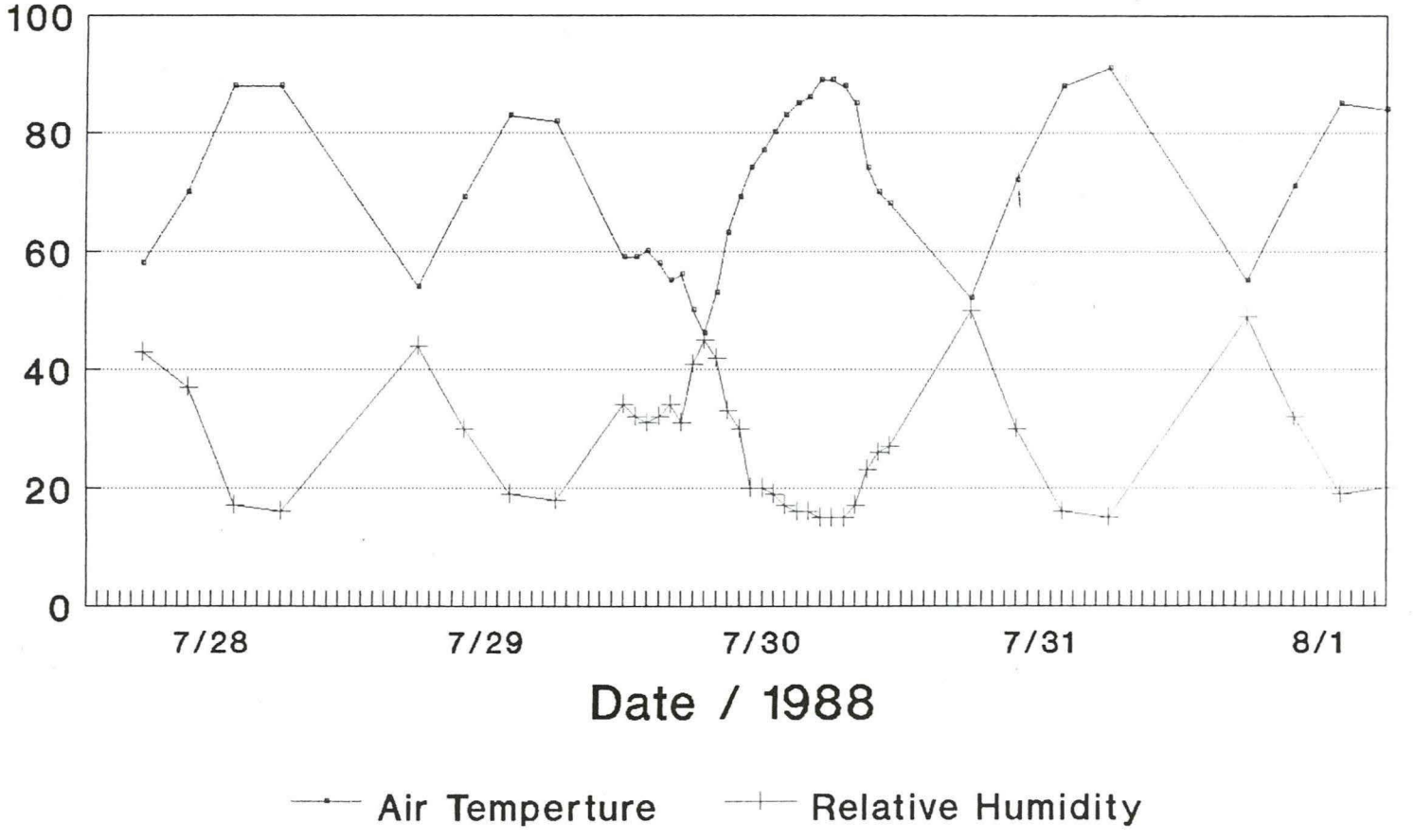


Figure 55. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, and average wind speed measurements for July 28 - August 1, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)

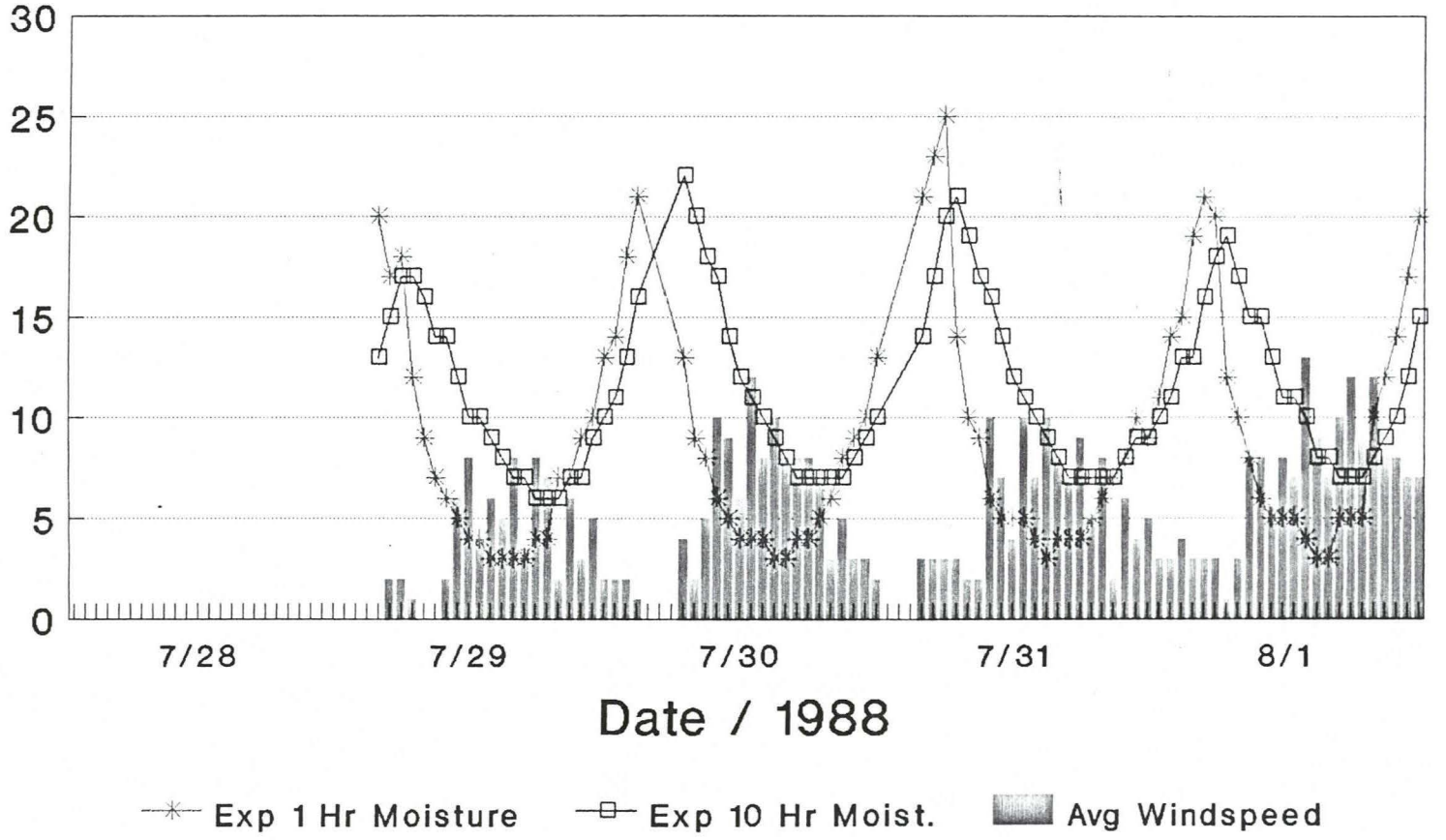
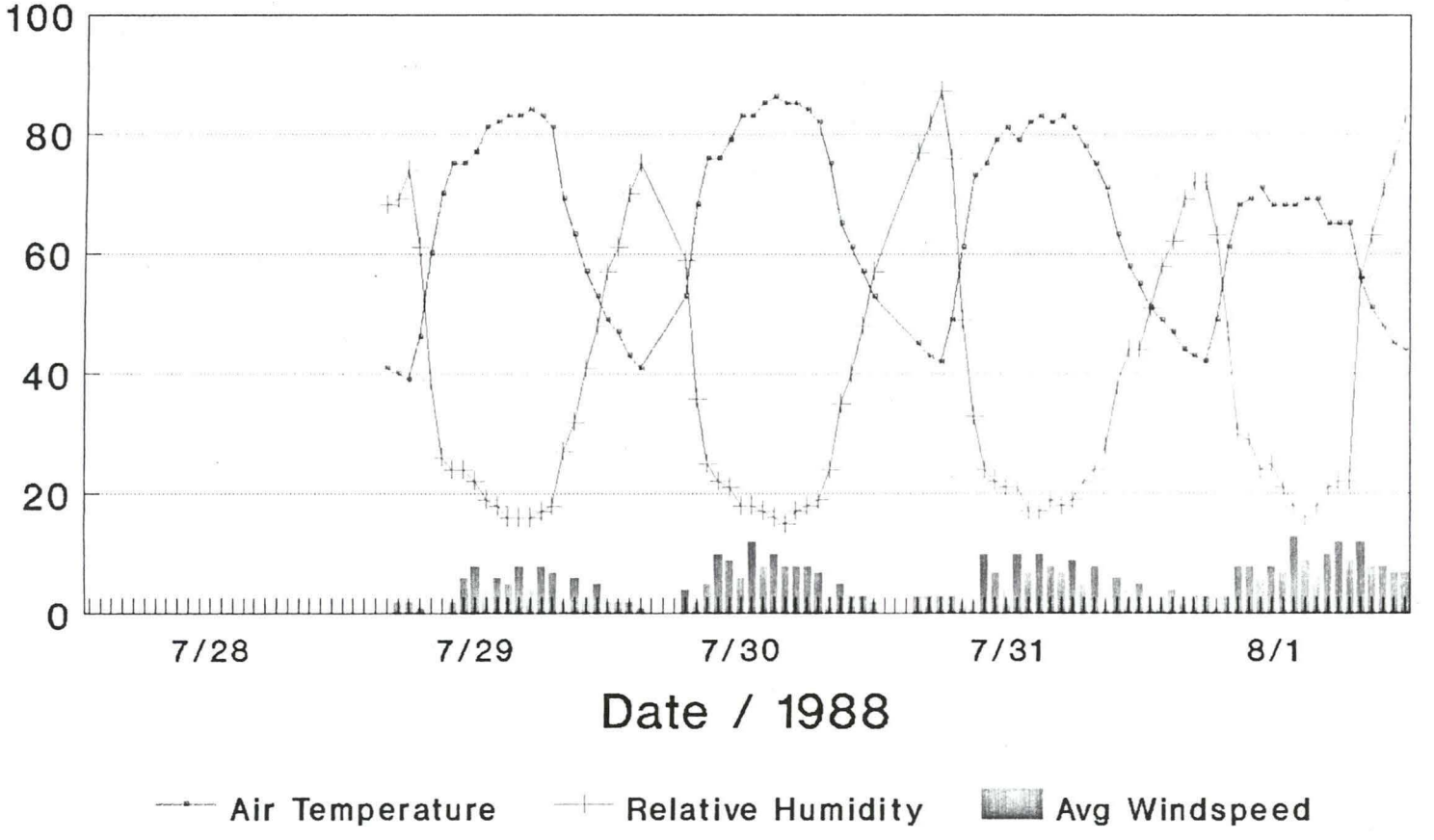


Figure 56. Benchmark RAWS Station air temperature and relative humidity, and average wind speed measurements for July 28 - August 1, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)



1502 hrs. "Smoke from fire in Missoula (Madison Gulch Fire west of Missoula) is starting to sock in valley at Clearwater. Probably won't be able to use Seeley airport by evening. Canyon is not active today. Gates Park is putting up a good column today." (Lolo National Forest, Fire Dispatch radio log, transmission from Dan Bailey)

1600 hrs. "DB 66, WB 47, RH 23, wind west 22-28 MPH. Visibility north - northwest poor from drift smoke." (Silver King Lookout radio log.)

2000 hrs. "DB 61, WB 45, RH 28, wind west / northwest 24-26. Not much happening on fire, laying down." (Silver King Lookout radio log.)

Regional Weather: During the night temperatures cooled into the 50's and 60's over most of the Region. Low temperatures for the morning ranged from 42 at West Yellowstone to 71 at Miles City. Most stations experienced good humidity recovery last night in combination with the cooler temperatures. With the morning forecasts came NWS Red Flag Warning for eastern Montana for gusty northwest winds to 25 MPH and low humidities of between 10-15%. During the afternoon partly cloudy to mostly sunny skies covered the Region as a weak Canadian cold front moved southeast through Montana. Westerly winds with gusts to 35 MPH were reported in western Montana and winds were picking up along the Hi-line. The westerly winds brought in heavy smoke from the Selway-Bitterroot Wilderness into the Bitterroot Valley and Missoula. Maximum high afternoon temperatures were in the 80's and 90's and ranged from 81 at West Yellowstone to 102 degrees at Baker. A weak upper level disturbance during the afternoon and evening caused some scattered showers over western and southern Montana mountains. West Yellowstone was the only regular reporting station to report any significant precipitation with .35" (Bushey, 1989).

JULY 29 (Julian Date 211)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 61.3
Actual ERC for the day: 62
Seeley Lake Ranger Station; 3-day running mean ERC: 48.0
Actual ERC for the day: no data

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 6.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 12-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 20-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 17-6%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 9-5% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
24 hr High-Low range, 1 Hr fuel: 11-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6-5%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 54-83
Monture 24 hr relative humidity range: 18-44%
(Monture 1500 hrs readings; 83F, 19%)
Benchmark 24 hr temperature range (degrees F): 39-84
Benchmark 24 hr relative humidity range: 16-74%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-8
(Benchmark 1346 hr readings; 83F, 16%, 5 MPH)

Fire Behavior: Fire spread was insufficient on this date to expand any fire perimeter. Fire activity was confined to low intensity ground and surface fires with considerable smoke which drifted with the light general and upslope winds. Probability of Ignition during the peak burning hours ranged from 50% at the higher elevations where the fire was burning to 60% near the North Fork of the Blackfoot River.

0800 hrs. "DB 52, WB 39, RH 30, no wind, clear! Some activity on fire. Northwest to hazey to see. Smoke coppery colored blanket." (Silver King Lookout radio log.)

1010 hrs. "Blanket smoke elevation 8000' to ground, no winds." (Silver King Lookout radio log.)

1200 hrs. "DB 59, WB 44, RH 30, wind south at 5 MPH. Very little activity on fire." (Silver King Lookout radio log.)

1300 hrs. "DB 65, WB 47, RH 25, wind west 12-16 MPH. Wind starting some activity on fire's northern part." (Silver King Lookout radio log.)

1415 hrs. "Good sized column of smoke northern edge, drifting northeast." (Silver King Lookout radio log.)

1500 hrs. "DB 65, WB 47, RH 25, winds southwest 14-18 MPH." (Silver King Lookout radio log.)

1530 hrs. "Can see several spot fires northeast slope Section 4 mountain middle 1/3 of mountain, on ridges in Section 3....Drift northeast." (Silver King Lookout radio log.)

1600 hrs. "DB 65, WB 45, RH 19, winds west 16-20 MPH. Moderately active." (Silver King Lookout radio log.)

1700 hrs. "Fire picking up North Fork area." (Silver King Lookout radio log.)

1900 hrs. "DB 66, WB 45, RH 16, wind west 14-16 MPH. Fire puffing up here and there within the burn itself. Drift northeast." (Silver King Lookout radio log.)

Regional Weather: Morning low temperatures were mostly in the upper 40's and 50's across the Region and ranged from 44 at West Yellowstone to 62 at both Miles City and Glasgow. Afternoon high temperatures ranged from 62 at Red Lodge to 100 at Hardin. In Missoula it had been sixteen days since that last rain, but the station was still ahead by .02" of the normal accumulative total for the season. This station had been ahead of the season total since May 30th. Eight of the last nine days the temperatures had been 90 degrees or

greater at this station. Sunny, warm and dry conditions were expected to continue throughout the Northern Rocky Mountains with high pressure rebuilding (Bushey, 1989).

JULY 30 (Julian Date 212)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 61.6
Actual ERC for the day: 62
Seeley Lake Ranger Station; 3-day running mean ERC: 49.0
Actual ERC for the day: 47

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 6.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 19-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 21-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 22-7%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 7-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 9-4% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%

RAWS Fire Weather: Monture 24 hr temperature range: 46-89F
Monture 24 hr relative humidity range: 15-45%
(Monture 1400 hrs readings; 80F, 19%)
Benchmark 24 hr temperature range: 43-85F
Benchmark 24 hr relative humidity range: 15-75%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-12
(Benchmark 1346 hr readings; 85F, 17%, 8 MPH)

Fire Behavior: Another day of very limited fire activity with no expansion of the fire perimeter. Fire activity was again restricted to ground and surface fires with considerable lightly drifting smoke creating an extensive haze. Probability of Ignition ranged from 60 to 70% during the burning period.

0800 hrs. "Dark, medium sized column, black-coppery colored, elevation of column 8800', drift northeast. Rest of fire inactive. DB 56, WB 42, RH 31, wind northwest 10-14 MPH." (Silver King Lookout radio log.)

1500 hrs. "Activity thru out fire picks up some, DB 74 degrees." (Silver King Lookout radio log.)

1530 hrs. "Wind west 18-26 MPH. Activity on fire has increased with several individual columns ranging from small to large throughout burn. Drift northeast." (Silver King Lookout radio log.)

1600 hrs. "Activity on fire increasing on northern end. Smoke about the same as yesterday." (Silver King Lookout radio log.)

1810 hrs. "Large column smoke north section of Canyon Fire." (Silver King Lookout radio log.)

1900 hrs. "DB 69, WB 49, RH 23, wind west 18-24. Large dark smoke, drift NE." (Silver King Lookout radio log.)

2000 hrs. "Fire laying down some. Smoke drift northeast. DB 68, WB 48, RH 22, winds west / northwest 24-26 MPH." (Silver King Lookout radio log.)

Regional Weather: Nighttime temperatures cooled into the 50's and 60's, ranging from 42 at West Yellowstone to 68 in Miles City. Upper level high pressure centered over the southern Idaho border created warm temperatures and blocked any moisture from entering into the Region. A very dry airmass covered Washington, Oregon, Idaho, Montana, and northwest Wyoming. During the afternoon it was sunny and hot across the Region with Missoula reaching 94 degrees, Billings 101, Miles City 104, and 105 in Broadus. Coolest afternoon location was Mullan, Idaho with 86 degrees. Relative humidities had low readings of 10 to 20%. Winds aloft were at 15 MPH and mixing at the surface. Relative humidity at night was not recovering, with only 35 to 45% maximum attained on the upper slopes and ridges (Bushey, 1989).

JULY 31 (Julian Date 213)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 61.6
Actual ERC for the day: 63
Seeley Lake Ranger Station; 3-day running mean ERC: 49.6
Actual ERC for the day: 52

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 6.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 11-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 12-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 25-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 20-7%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 10-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 12-4% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%

RAWS Fire Weather: Monture 24 hr temperature range (degrees F): 52-91
Monture 24 hr relative humidity range: 15-50%
(Monture 1500 hrs readings; 88F, 16%)
Benchmark 24 hr temperature range (degrees F): 42-83
Benchmark 24 hr relative humidity range: 17-87%
Benchmark 24 hr average 20 ft wind speed range (MPH): 3-10
(Benchmark 1346 hr readings; 83F, 17%, 10 MPH)

Fire Behavior: Mapping of the fire showed spread in the drainages and ridges to the southwest of the Dry Fork, above its junction with the North Fork of the Blackfoot River there was further spread to the southwest and upslope. Fire spread was also mapped up valley and upslope from the North Fork of the Blackfoot River with the majority of the spread being upslope in the side drainages, especially to the northeast of Falls Point Mountain. The Probability of Ignition on this day ranged from 60 to 70%. Approximately 1,521 acres were burned on this date. Total within fire perimeter acreage expanded to 20,953 acres.

0700 hrs. "Clear, calm; no activity on fire." (Silver King Lookout radio log.)

1450 hrs. "Activity increasing on fire, same area as yesterday, north end of Canyon Fire. Winds W 18-24. Smoke drift to the NE." (Silver King Lookout radio log.)

1500 hrs. "DB 68, WB 46, RH 16. Column growing quickly from gray to coppery-black plume, 12-1400' elevation, drift northeast. 295 degrees 15'." (Silver King Lookout radio log.)

1515 hrs. "Increasing activity all through, two individual columns putting up hugh quantities of black smoke. 283 degrees 20' southwest." (Silver King Lookout radio log.)

1525 hrs. "Three individual columns, now looks like all three could make major runs." (Silver King Lookout radio log.)

1600 hrs. "DB 68, WB 47, RH 19. Three different columns at times. Clouding up, hi-mid clouds, haven't seen any cumulus."
(Silver King Lookout radio log.)

1700 hrs. "All smokes decreasing, temperatures 70 degrees, wind west 16-24." (Silver King Lookout radio log.)

Regional Weather: High pressure persisted over the region through the morning as hot temperatures again began to build. Morning low temperatures ranged from 45 at West Yellowstone to 68 at Broadus. The NWS issued a Red Flag for the western portion of the Northern Region due to the continued hot, dry weather, and a chance of afternoon dry lightning and associated winds. Afternoon temperatures rose into the 90's across the Region, ranging from 82 at Mullan, Idaho to 101 in Broadus. Strong southwest winds created problems on many fires as 35 to 40 MPH gusts contributed to crowning and spotting behavior. During the late hours of the day thunderstorms started to breakout over northwestern Montana and far eastern Montana (Bushey, 1989).

Miscellaneous: This would be the day that Headquarters Creek on the Gates Park Fire would burn (Bonney, 1988). During the afternoon this fire made two runs up southwest facing drainages, Spruce and Headquarters drainages, adding newly burned areas approximately six miles in length and one to two miles wide (Bushey, 1989).

AUGUST 1 (Julian Date 214)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 60.3
Seeley Lake Ranger Station; 3-day running mean ERC: 50.3

The Seeley Lake Ranger Station reaches it's highest ERC level for the 1988 season.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 7.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 11-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 12-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 21-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 19-7%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 10-5% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
24 hr High-Low range, 1 Hr fuel: 12-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

RAWS Fire Weather: Monture 24 hr temperature range: 55-85F
Monture 24 hr relative humidity range: 19-49%
(Monture 1500 hrs readings; 85F, 19%)
Benchmark 24 hr temperature range: 42-69F
Benchmark 24 hr relative humidity range: 16-83%
Benchmark 24 hr average 20 ft wind speed range (MPH): 3-13
(Benchmark 1346 hr readings; 68F, 18%, 13 MPH)

Fire Behavior: No significant fire activity reported. Probability of Ignition dropped down to a 50 - 60% range for the peak burning period.

0700 hrs. "52 degrees, clear, calm. No fire activity on either fires." (Silver King Lookout radio log.)

1130 hrs. "Front moving in from northwest, several cumulus building." (Silver King Lookout radio log.)

1300 hrs. "Winds pickup northwest 28-36 MPH, 58 degrees. No activity on fires." (Silver King Lookout radio log.)

1320 hrs. "Column seen coming up north edge of fire." (Silver King Lookout radio log.)

1401 hrs. "Increasing activity due to wind, low 30's." (Silver King Lookout radio log.)

1600 hrs. "Wind northwest 24-32 MPH. Thick blanket smoke throughout burn, no columns." (Silver King Lookout radio log.)

1625 hrs. "Column seen on west slope Section 4 mountain near top." (Silver King Lookout radio log.) [Note; Mineral Mountain.]

1730 hrs. "Fire activity most everywhere, can't see anyone place more active than any (other) place on fire, thick blanket smoke 12,000 ft elevation drift northeast." (Silver King Lookout radio log.)

1800 hrs. "Smoke socking in bottoms." (Silver King Lookout radio log.)

2300 hrs. ""Socked in." (Silver King Lookout radio log.)

Regional Weather: Skies cleared over the western portion of the Region, while scattered precipitation and thunderstorms were being reported from the eastern portion as a pacific cool front moved across the Region. Moderate to heavy rain was reported in Alberta but was not spreading very far south. A little moisture fell in northern Idaho around Bonners Ferry. Associated with that particular cell of moisture was an area of lightning which was concentrated at Bonners Ferry and extended east across northern Montana to the eastern edge of Glacier National Park. Another cell was located above Glasgow in eastern Montana. At 0600 hrs Cutbank had the mornings coolest temperature of 49 with gusty northwest winds and cloudy skies. Billings was the warmest morning location with 77 degrees. Strong southwest winds to 40 MPH occurred in the Yellowstone area as the dry cold front moved through that vicinity. Afternoon temperatures ranged from 75 at Missoula to 95 at Broadus. Afternoon thunderstorms developed in east-central South Dakota and on the Wyoming / Montana stateline north of Buffalo, Wyoming (Bushey, 1989).

Long-Range Weather Forecast: The 30 day outlook was issued by the NWS and indicated that August would be cooler than normal in the western two-thirds of the Region, while the eastern one-third would have warmer than normal temperatures. Precipitation during August was expected to be heavier than normal in northern Idaho while across Montana moisture was expected to be lighter than normal.

The 90 day forecast for August through October indicted that temperatures might be cooler than normal across the Region, and that heavier than normal precipitation could also occur (Bushey, 1989).

August 2 (Julian Date 215)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 57.6
Seeley Lake Ranger Station; 3-day running mean ERC: 49.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 18-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 26-6%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 25-11%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 9-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%
24 hr High-Low range, 1 Hr fuel: 12-7% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 8-7%

RAWS Fire Weather: Monture 24 hr temperature range: 58-74F
Monture 24 hr relative humidity range: 15-48%
(Monture 1400 hrs readings; 74F, 18%)
Benchmark 24 hr temperature range: 33-65F
Benchmark 24 hr relative humidity range: 33-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 2-10
(Benchmark 1346 hr readings; 62F, 39%, 8 MPH)
(figures 57 - 60)

Fire Behavior: Burning continued on the slopes above Sarbo Creek and the North Fork of the Blackfoot River on the southeast side of Evans Peak. The range of Probabilities of Ignition covering the peak burning period on this day was 40 to 60%. An additional 688 acres were mapped bringing the total within fire perimeter acreage to 21,641 acres.

1000 hrs. "Routine check in. Socked in all morning, just breaking out. Winds calm N 5-10 MPH." (Silver King Lookout radio log.)

1100 hrs. "Clear. No activity on fires. No wind, 47 degrees." (Silver King Lookout radio log.)

1800 hrs. "No activity on Canyon fire." (Silver King Lookout radio log.)

Regional Weather: The area of low pressure had spread some spotty moisture into the Region with Lewistown being typical and receiving only .07". Shower activity was also still occurring in northern Idaho where significant amounts of rain fell during the previous 24 hr period. The AFFIRMS station at St. Mary's (eastside of Glacier National Park) received .80" of rain! Saddle Pass RAWS in northern Idaho recorded .32". The RAWS stations at Flat Willow (south of Lewistown) and at Zortman (northcentral Montana) received .22". The Benchmark RAWS on the east slope of the Northern Rocky Mountains near the Gates Park Fire, reached 100% relative humidity though no rain was received. Scattered thunderstorms occurred across eastern Montana during the night and early morning hours. Low morning temperatures ranged from 39 degrees at West Yellowstone up to 68 at Miles City. The Red River RAWS on the Clearwater River, Nez Perce National Forest, (not an official weather service station) hit 32 degrees at 0300 hrs. Afternoon temperatures were in the 70's across the Region, and ranged from 69 at Mullan, Idaho to 80 at Broadus, Montana. Two areas of lightning concentration developed during the afternoon, south of Couer d'Alene on the Clearwater and Idaho Panhandle National Forests, and south of Yellowstone National Park on the Bridger-Teton National Forest and over the Big Horn Mountains. Scattered strikes also occurred throughout the Missouri River basin from east of Lewistown all the way over to the northeast corner of the Region (Bushey, 1989).

Figure 57. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for August 2 - August 6, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

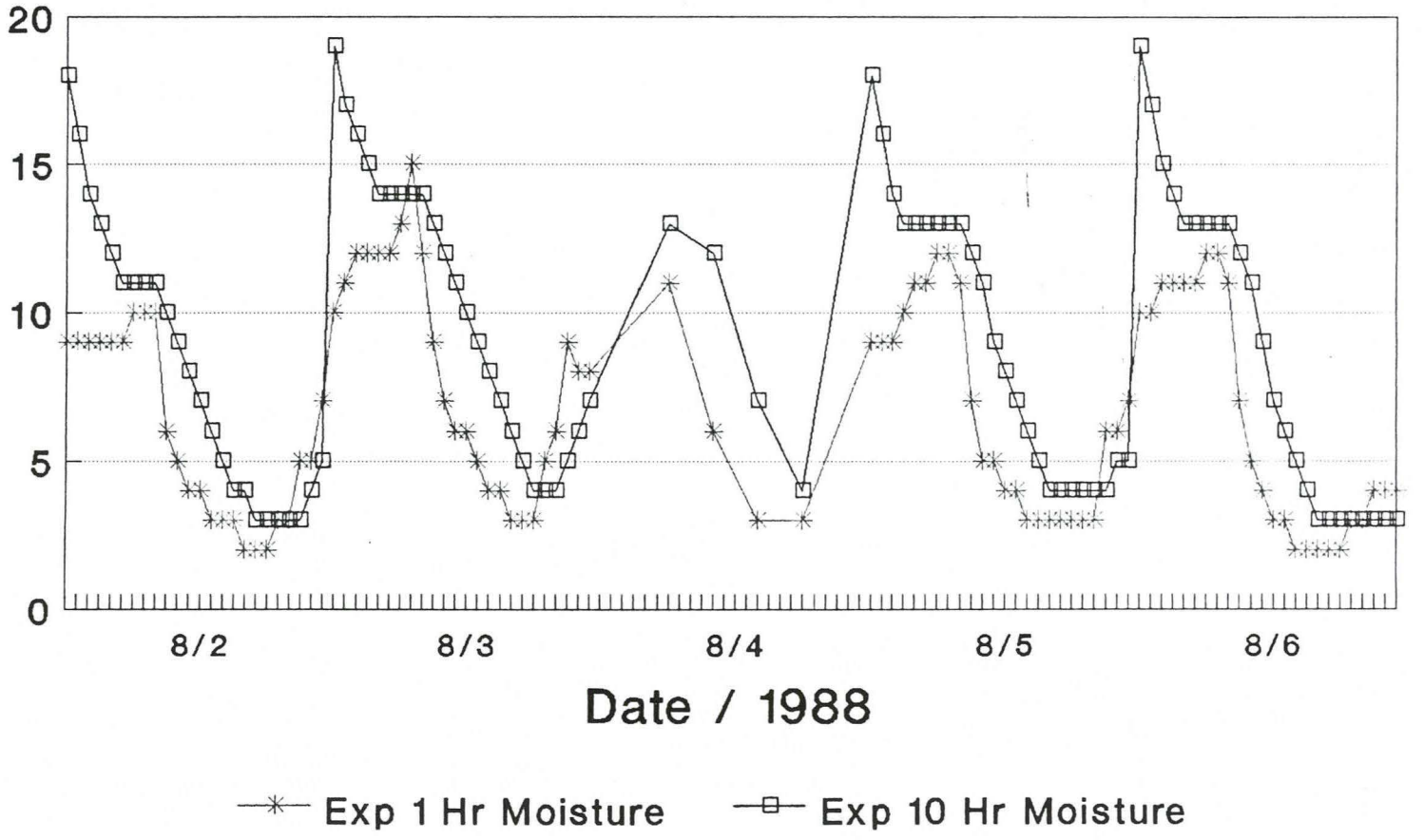


Figure 58. Monture RAWS Station air temperature and relative humidity measurements for August 2 - August 6, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

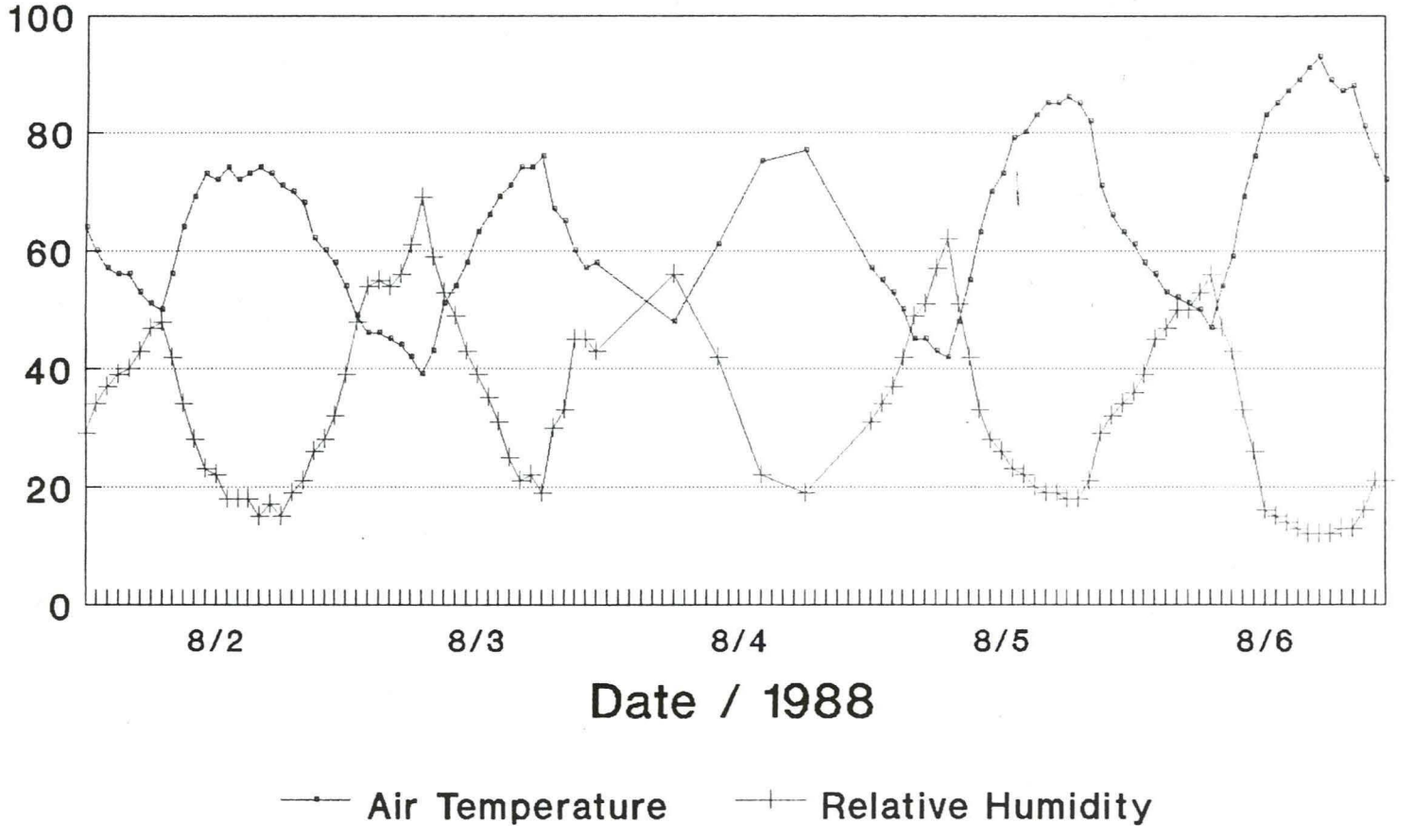


Figure 59. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, and average wind speed measurements for August 2 - August 6, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)

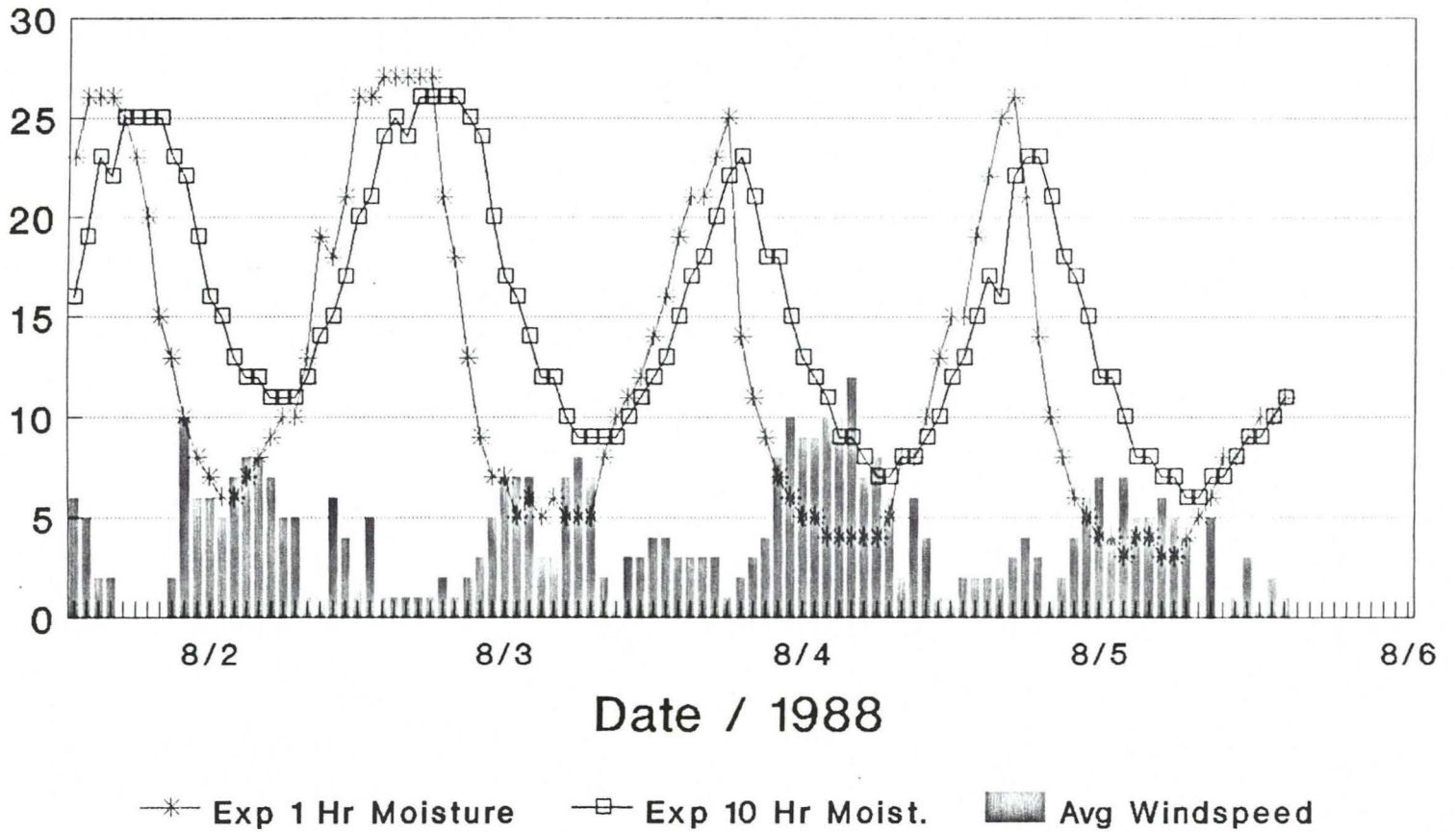
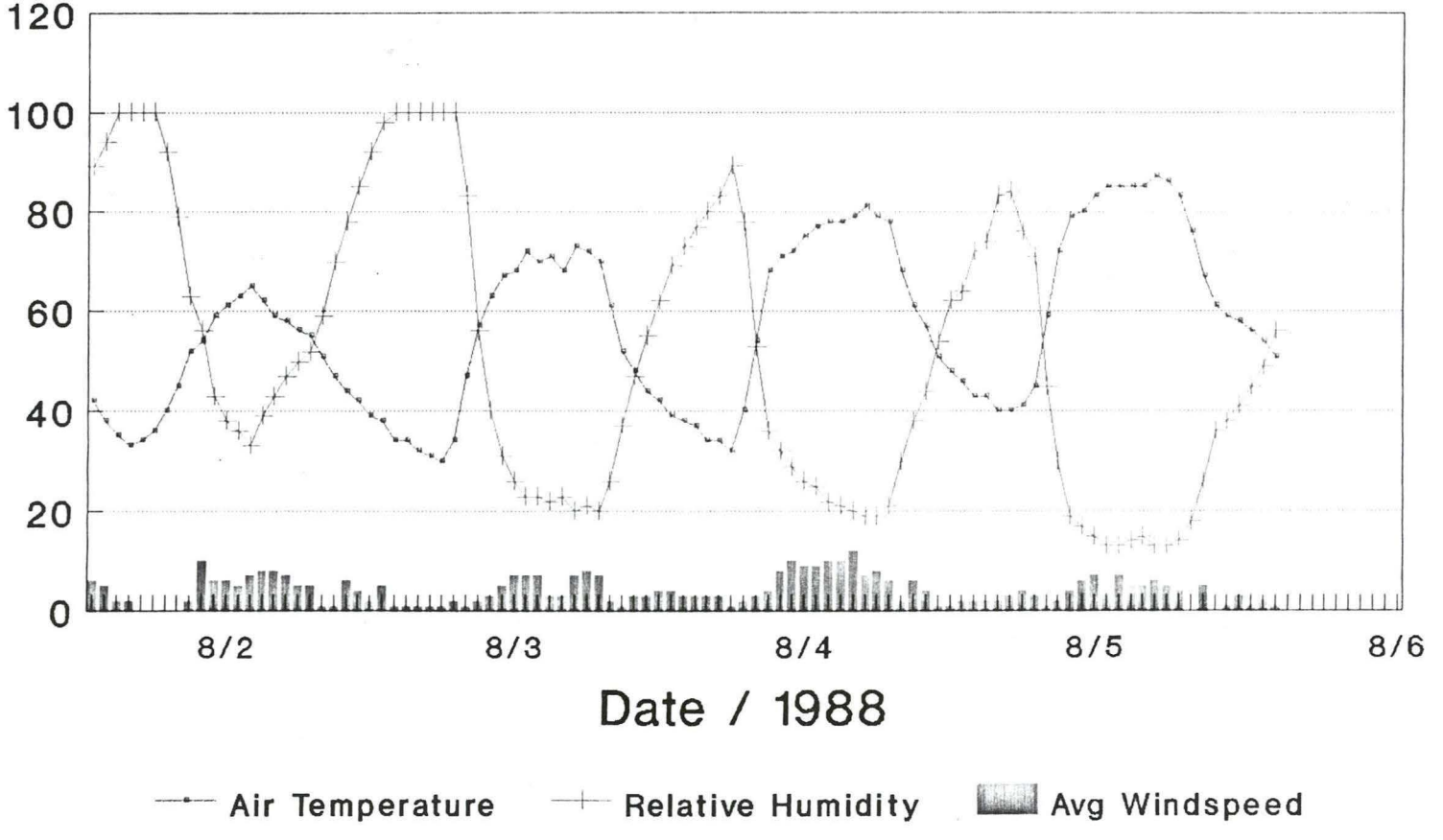


Figure 60. Benchmark RAWS Station air temperature and relative humidity, and average wind speed measurements for August 2 - August 6, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)



AUGUST 3 (Julian Date 216)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 56.3
Seeley Lake Ranger Station; 3-day running mean ERC: 48.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 13.6%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 15-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 19-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-5%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 26-9%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 12-6% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 8-7%
24 hr High-Low range, 1 Hr fuel: 13-7% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 8-7%

RAWS Fire Weather: Monture 24 hr temperature range: 39-74F
Monture 24 hr relative humidity range: 19-69%
(Monture 1400 hrs readings; 66F, 35%)
Benchmark 24 hr temperature range: 30-73F
Benchmark 24 hr relative humidity range: 20-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-8
(Benchmark 1346 hr readings; 71F, 22%, 3 MPH)

Fire Behavior: Light meandering smoke from ground fires, stumps, logs etc. Only local hot spots evident in area north of Carmichael Guard Station. Across Broadus Creek and into Cabin Creek very widely scattered hot spots exhibiting 2-3' flame lengths. Most of the perimeter appears out except for scattered spots and ground fire (Lolo National Forest video interpreted by Bushey). During the peak burning period the Probability of Ignition ranged on the fire from 30 - 40%. No new acreage was added to the fire perimeter. The fire size at the time was estimated to be about 22,200 acres (USDA Northern Region, 1989), this was a little greater than the digitized acreage for the previous day of 21,641 acres.

0700 hrs. "Overcast, .02" of precipitation, broken hail between 0430-0440 hrs. Low temperature last night was 36 degrees, currently 44, wind calm, ground wet." (Silver King Lookout radio log.)

0922 hrs. "Blanket smoke from Canyon Fire drifting in valleys." (Silver King Lookout radio log.)

1400 hrs. "Little activity on Canyon Fire." (Silver King Lookout radio log.)

Regional Weather: The upper trough of low pressure extended from the northeast corner of Montana down through the southwest corner of the Region during the morning. Shower and thunderstorm activity was still occurring ahead of the line, with most of the morning activity concentrated in southeast Montana.

Overnight low temperatures as of 0600 hrs ranged from 39 degrees at Butte to 61 at Broadus. By the afternoon cloudy skies still covered eastern Montana, but high pressure and clear skies were rebuilding over the western portion of the Region with only very isolated thunderstorms. Afternoon temperatures were mild and mostly in the 70's, ranging from 66 at Broadus to 87 at Thompson Falls. Winds at Billings were east at 10 to 20 MPH. Skies were sunny across Washington and Oregon with temperatures generally in the 80's with a few low 90's (Bushey, 1989).

AUGUST 4 (Julian Date 217)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 57.3
Seeley Lake Ranger Station; 3-day running mean ERC: 48.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 13.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 11-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 13-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 25-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 23-7%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 13-5% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
24 hr High-Low range, 1 Hr fuel: 15-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6%

RAWS Fire Weather: Monture 24 hr temperature range: 48-77F
Monture 24 hr relative humidity range: 19-56%
(Monture 1400 hrs readings; 61F, 42%)
Benchmark 24 hr temperature range: 32-81F
Benchmark 24 hr relative humidity range: 19-89%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-12
(Benchmark 1346 hr readings; 78, 21%, 10 MPH)

Fire Behavior: Fire continued to spread to the southwest with light upslope winds in the drainages and ridges leading up from the Dry Fork of the North Fork of the Blackfoot River toward Lake Mountain. North of Lake Mountain this fire burned to the ridge top but did not spot across the ridge to the west facing aspect (Sisk interview). Additional easterly spread also occurred as the fire continued upslope movement above the fire's place of origin and on the ridge to the north of Canyon Creek. Probability of Ignition during the afternoon peak burning period ranged from 50 - 60% at the lower elevations to only 50% at the higher forested sites. The fire's acreage was estimated on this date to be 22,400 acres (USDA Northern Region, 1989). Later digitized mapping would show that an additional 1,832 acres were burned bringing the within fire perimeter acreage to 23,423 acres.

0700 hrs. " Clear, sunny, 54 degrees, calm. No activity on fires." (Silver King Lookout radio log.)

1030 hrs. "Light-moderate activity on Canyon Fire, thick coppery blanket smoke socked in valley bottoms." (Silver King Lookout radio log.)

1400 hrs. "Upper valleys getting smoked out, can see large dark column southwest area Canyon Fire. Still alot of blanket smoke, poor visibility." (Silver King Lookout radio log.)

Regional Weather: A warm, dry ridge of high pressure continued to build over the Region. Skies were fair across the Region during the night with cool temperatures in the west and mild in the east. Lows at 0600 hrs ranged from 34 at West Yellowstone and 38 at Butte to 55 at Miles City and 56 at Broadus. Slight temperature inversions were beginning to be experienced across the entire Region and particularly in mountain valleys under the current high pressure. Smoke was laying down from the low intensity burning of the past several days and was becoming trapped under the inversion layer. Valleys receiving cool, nighttime air drainage were experiencing particularly high concentrations of particulates. Most inversions were breaking by 1000 hrs. By the afternoon only a few clouds were left over southeastern Montana from the disturbance that had recently left the Region. Winds east of the divide were mostly in the 10 to 20 MPH range, while west of the divide they were generally light. Afternoon temperatures were in the upper 70's and 80's, ranging from 78 at West Yellowstone to 96 at Thompson Falls (Bushey, 1989).

AUGUST 5 (Julian Date 218)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 58.6
Seeley Lake Ranger Station; 3-day running mean ERC: 45.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 7.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 13.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 12-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 18-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 26-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 23-6%

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 11-5% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
24 hr High-Low range, 1 Hr fuel: 13-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6%

RAWS Fire Weather: Monture 24 hr temperature range: 42-86F
Monture 24 hr relative humidity range: 18-62%
(Monture 1400 hrs readings; 79F, 23%)
Benchmark 24 hr temperature range: 40-87F
Benchmark 24 hr relative humidity range: 13-84%
Benchmark 24 hr average 20 ft wind speed range (MPH): 2-7
(Benchmark 1346 hr readings; 85F, 14%, 5 MPH)

Fire Behavior: During the afternoon the fire continued burning upslope on the northeast flanks of Lake Mountain pushed by light upslope winds. Burning upslope from the Dry Fork of the North Fork of the Blackfoot River, the fire continued to make short upslope runs within the area burned the previous day, burning intensely toward the ridgetop. In an area just north of Lake Mountain peak the fire spotted across the ridge onto the west facing aspect and was smoldering in small patches of subalpine fir just below the ridge (Sisk interview). These spots would remain smoldering for the next 18 days. approximately 932 acres were mapped as having burnt on this date. Much of the newly burned acreage on this date occurred on the east facing, upper slope of Lake Mountain where a burnout operation was completed during the afternoon with the aid of upslope winds and downslope scree. These efforts were to protect the fire management area's boundry. Total within perimeter fire acreage expanded to 24,405 acres. Probability of Ignition during the afternoon burning period ranged from 60% on lower elevation sites to 50% at the higher locations.

1030 hrs. "Activity on Canyon Fire, west slope off of north ridge of Mineral Mountain, same area as yesterday. 281 degrees 30'. Wind southwest 6-12 MPH. Black-coppery colored smoke from head of Jakie Creek basin area, Section 7." (Silver King Lookout radio log.) [Note; Fire was 1 1/2 miles north of this reported position.]

1447 hrs. "Gonna burn pocket out on east side of Lake Mountain this PM. Torching trees right now." (Lolo National Forest, Fire Dispatch radio log; transmission from fire crew to aerial observer)

1530 hrs. "Black smoke column southwest end of fire." (Silver King Lookout radio log.)

1545 hrs. "Smoke to west of Lake Mountain." (Silver King Lookout radio log.)

Miscellaneous: The Lodgepole Creek fire on the Flathead and Lewis and Clark National Forests started today (USDA Northern Region, 1989). This fire was at the northern end of the Bob Marshall Wilderness complex.

Regional Weather: The ridge of high pressure continued to dominate the weather across the Region on this date. Clear skies prevailed across the Region during the night. Morning 0600 hrs temperatures ranged from 33 degrees at West Yellowstone to 63 at Billings and Miles City. Temperatures climbed rapidly and by the afternoon were into the upper 80's and 90's. Afternoon high temperatures ranged from 84 degrees at West Yellowstone to 100 at Thompson Falls and Miles City. A few scattered showers were occurring across northern Idaho and skies were partly cloudy across Washington and Idaho. Late afternoon radar showed a large band of thunderstorms from southern Oregon to southern Nevada. Coastal showers were falling along western Washington (Bushey, 1989).

Weather Summary for the Week Ending August 5th.

	Temperature		Precipitation	
Station	High	Low	Past Week	% Normal
Missoula	96	43	0.08	112
Helena	96	47	NONE	84
Augusta	94	39	NONE	50

Precipitation normals represent accumulations since April 1st in Montana.

AUGUST 6 (Julian Date 219)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 60.0
Seeley Lake Ranger Station; 3-day running mean ERC: 44.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 8.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 13.6%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 12-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 19-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: no data
Benchmark, 24 hr High-Low range, 10 Hr fuel: no data

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 10-3% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4-3%
24 hr High-Low range, 1 Hr fuel: 13-4% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%

RAWS Fire Weather: Monture 24 hr temperature range: 47-93F
Monture 24 hr relative humidity range: 12-56%
(Monture 1400 hrs readings; 85F, 15%)
Benchmark 24 hr temperature range: no data
Benchmark 24 hr relative humidity range: no data
Benchmark 24 hr average 20 ft wind speed range (MPH):nodata
(Benchmark 1346 hr readings; no data)

Fuel Moistures: Approximately 3" diameter dead, sound wood collected near the summit of Lake Mountain (about 8200 ft elevation msl) and near the bottom of Lake Creek (about 5000 ft elevation msl) were 7.5% and 8.9% respectively (collected by J. Williams; USDA Northern Region, 1989). Other 1000 Hr fuel readings collected at approximately the 7000 ft msl level on Lake Mountain ranged between 5 - 7% (Sisk interview).

Fire Behavior: Continued burning of ground and surface fuel with very limited fire spread which was being controlled by upslope and up valley winds, and areas of light fuel concentration. No perimeter expansion was mapped. Probability of Ignition ranged from 70 - 80% within the Wilderness.

Helicopters were working hot spots located between Lake Mountain and the North Fork of the Blackfoot capitalizing on a period of higher humidities and light rain (USDA Northern Region, 1989).

0700 hrs. "Overcast, trying to rain but not reaching the ground, 50 degrees, winds south 5-10 MPH." (Silver King Lookout radio log.)

1300 hrs. "No activity on fires." (Silver King Lookout radio log.)

1400 hrs. "Winds west 22-26 MPH. No activity on fires." (Silver King Lookout radio log.)

Regional Weather: Skies were variably cloudy across the Region last night with an increase in upper and mid-level moisture. Radar indicated a few light showers over southwestern Montana in the morning and Butte reported a shower shortly after 0400 hrs as three weeks of dry weather was broken. At the surface an area of low pressure was causing 10 to 15 MPH winds at many locations. Temperature readings at 0500 hrs ranged from 58 degrees at Butte to 77 at Belgrade and 78 at Miles City. Later in the morning a band of showers developed accompanying a Pacific frontal passage moving through western Montana. Light rains were shown on radar from Kalispell to Seely Lake onto the west slopes of the Rockies. Rainfall amounts were less than a .25", with most stations recording less than .1". Anaconda and Seely Lake recorded .19", Polson .12", in addition to the stations reported below. Elsewhere it remained dry and clouds were breaking up over northern Idaho. Winds with the front were generally in the 15 to 25 MPH range. By mid-afternoon the front had progressed into the eastern third of the Region with much cooler air moving in behind the system from the west and northwest. Windy weather was common across the Region during the day; Livingston reached gusts of 66 MPH, Bozeman had 58 MPH gusts. Afternoon temperatures were in the upper 60's and 70's, with the Regional high temperatures being 101 at Miles City and 102 at Broadus (Bushey, 1989).

Miscellaneous: The Lodgepole Creek Fire, discovered the previous day on the Flathead National Forest portion of the Bob Marshall Wilderness, rapidly expanded under strong winds. The fire went from 20 acres to 600 in a four hour period of time as winds drove and spotted the fire up ridges and over adjacent slopes in cigar shaped patterns (Bushey, 1989).

The area of extreme drought indicated by the Palmer Drought Severity Index in southcentral Montana had become included within the extreme drought category. This left all of Montana, except a very narrow band along the western border in extreme drought. Northern Idaho was still maintaining moist soil conditions (Bushey, 1989).

AUGUST 7 (Julian Date 220)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 59.6
Seeley Lake Ranger Station; 3-day running mean ERC: 43.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 9.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 53-4%
Monture, 24 hr High-Low range, 10 Hr fuel: 29-7%
Benchmark, 24 hr High-Low range, 1 Hr fuel: no data
Benchmark, 24 hr High-Low range, 10 Hr fuel: no data

BEHAVE Fuel Moisture: 24 hr High-Low range, 1 Hr fuel: 17-12% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 17-14%
24 hr High-Low range, 1 Hr fuel: 17-12% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 17-14%

RAWS Fire Weather: Monture 24 hr temperature range: 53-73F
Monture 24 hr relative humidity range: 18-76%
(Monture 1400 hrs readings; 65F, 43%)
(Monture received .02" of rain between 1100-1200 hrs, first rain since the morning of July 13th, 25 days earlier.)
Benchmark 24 hr temperature range: no data
Benchmark 24 hr relative humidity range: no data
Benchmark 24 hr average 20 ft wind speed range (MPH):nodata
(Benchmark 1346 hr readings; no data)
(figures 61 - 64)

Fire Behavior: Continued burning of ground and surface fuels with little spread of the fire perimeter. Scattered rain and higher relative humidities kept the fire behavior down. Probability of Ignition ranged from 10 to 20% during the peak burning period.

Regional Weather: Some cloudiness still lingered in southeastern and southcentral Montana during the night from the passage of the Pacific cold front. By 0500 hrs skies were generally clear to partly cloudy over most of the Region with northwesterly winds 10 to 15 MPH. Temperatures were much cooler with western readings in the 40's, and mild in the south and east in the 60's. At 0500 hrs morning temperatures ranged from 40 degrees at Butte to 64 at Miles City. As the morning progressed the weather system moved out of the Region allowing wind speeds to diminish to 10 to 20 MPH in the east and light elsewhere. Isolated thunderstorms developed in western Montana during the afternoon, partly cloudy skies elsewhere. Temperatures rose into the upper 60's and 70's, ranging from 68 at Cutbank to 85 at Thompson Falls (Bushey, 1989).

AUGUST 8 (Julian Date 221)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 61.3
Seeley Lake Ranger Station; 3-day running mean ERC: 44.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 6.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.6%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel:insufficient data
Monture, 24 hr High-Low range, 10 Hr fuel: insuff. data
Benchmark, 24 hr High-Low range, 1 Hr fuel: no data
Benchmark, 24 hr High-Low range, 10 Hr fuel: no data

Figure 61. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, and precipitation measurements for August 7 - August 11, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

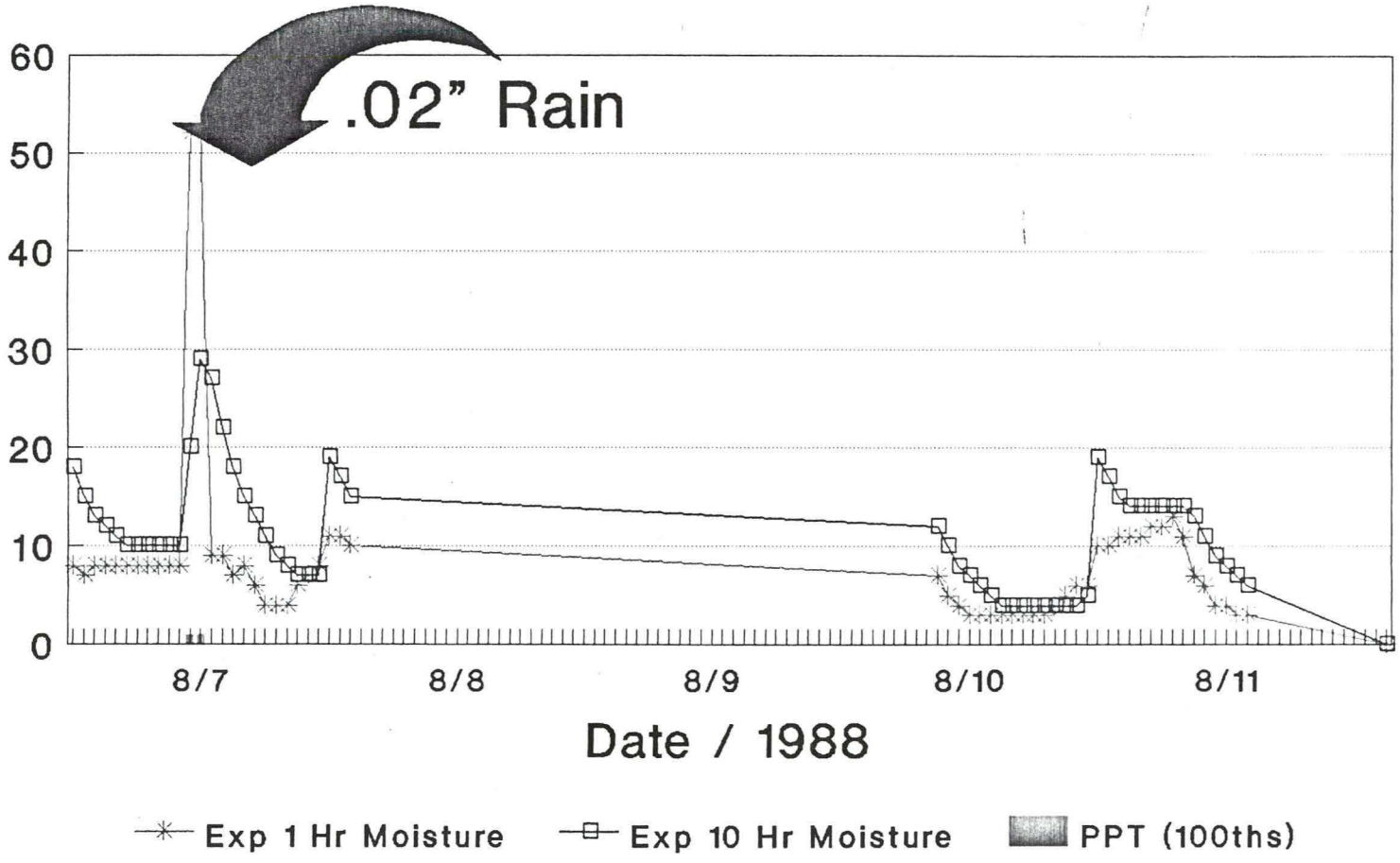


Figure 62. Monture RAWS Station air temperature and relative humidity, and precipitation measurements for August 7 - August 11, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

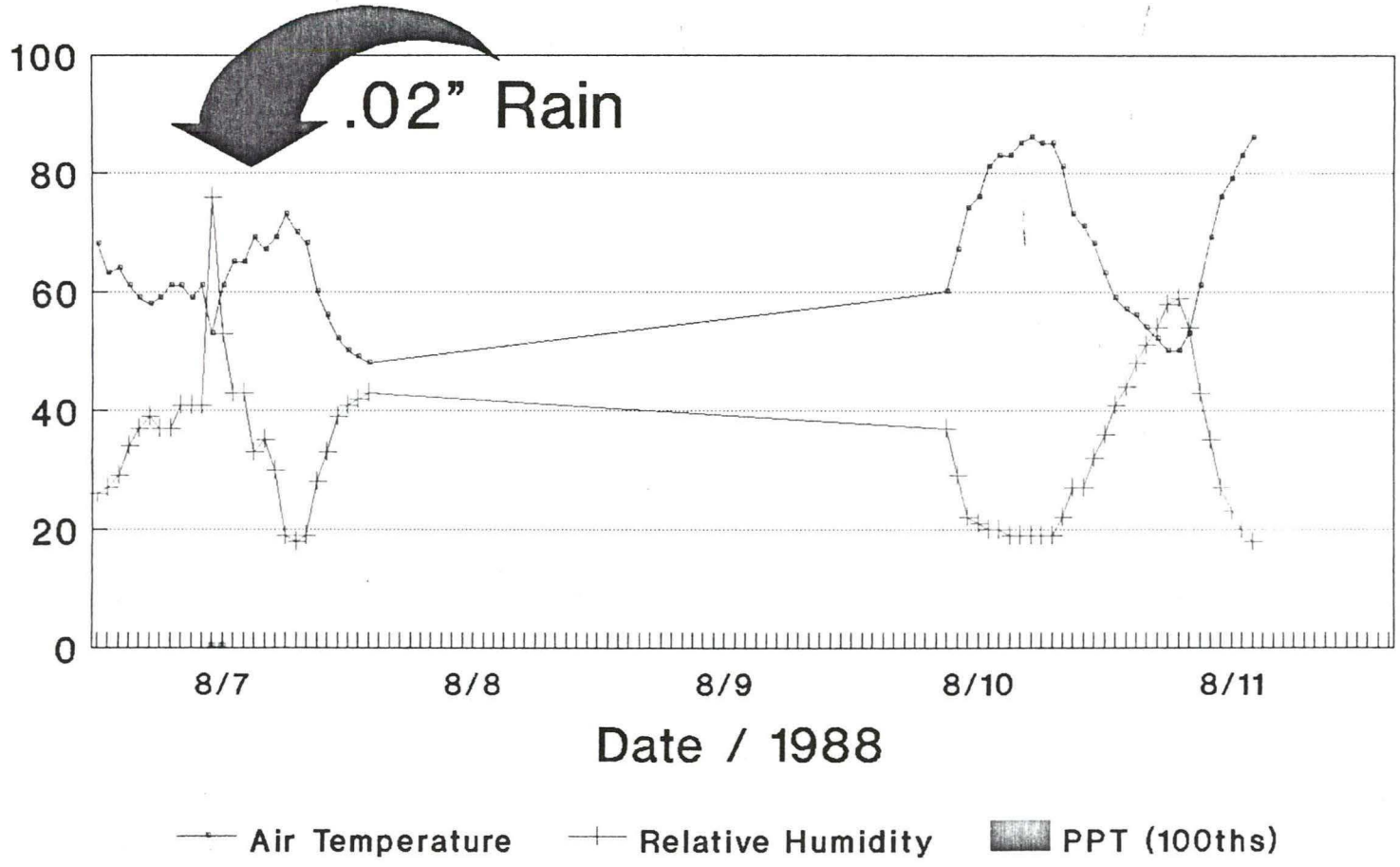


Figure 63. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for August 7 - August 11, 1988 (MST).

Fire Weather
Benchmark RAWS (323331FE)

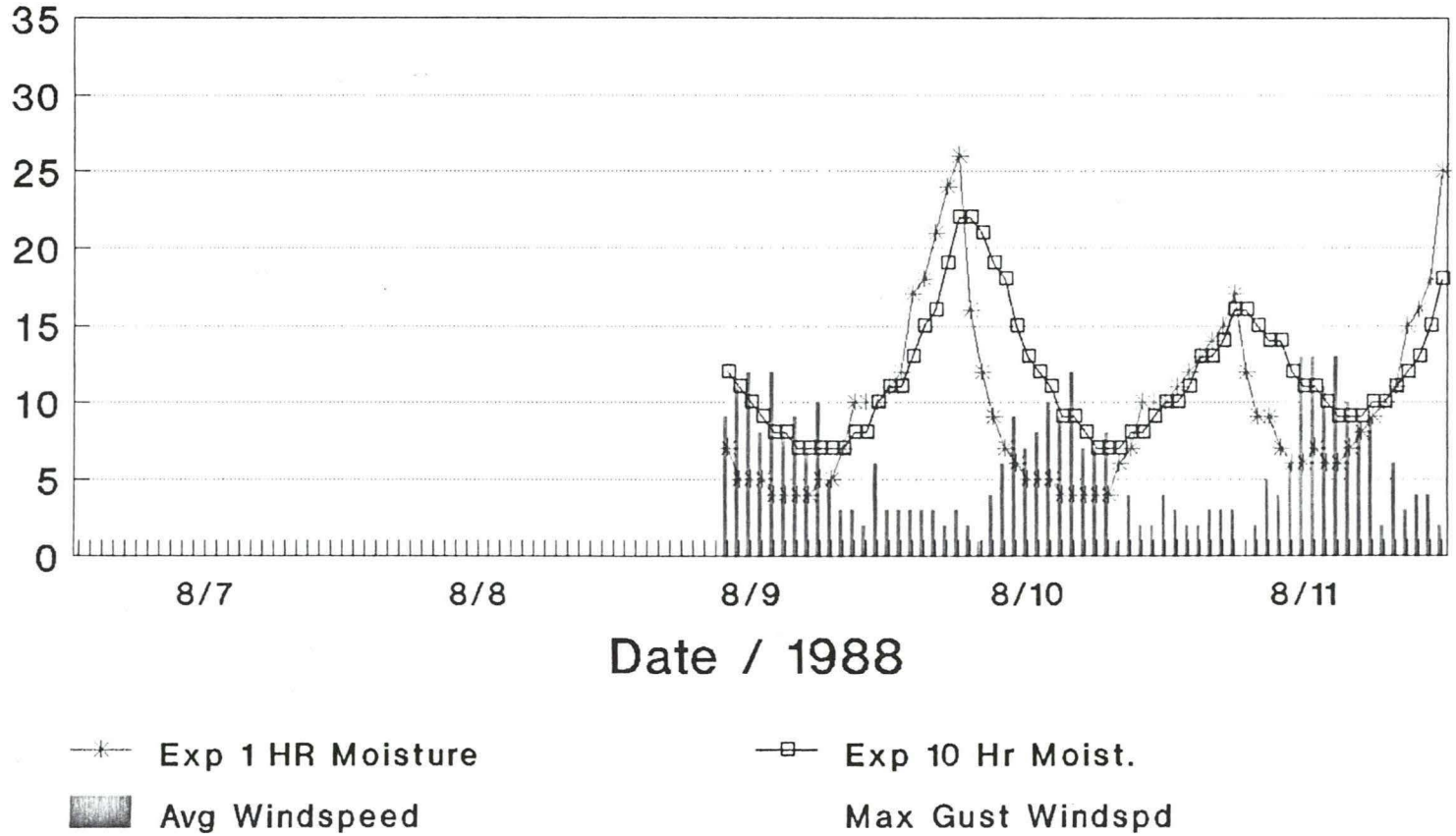
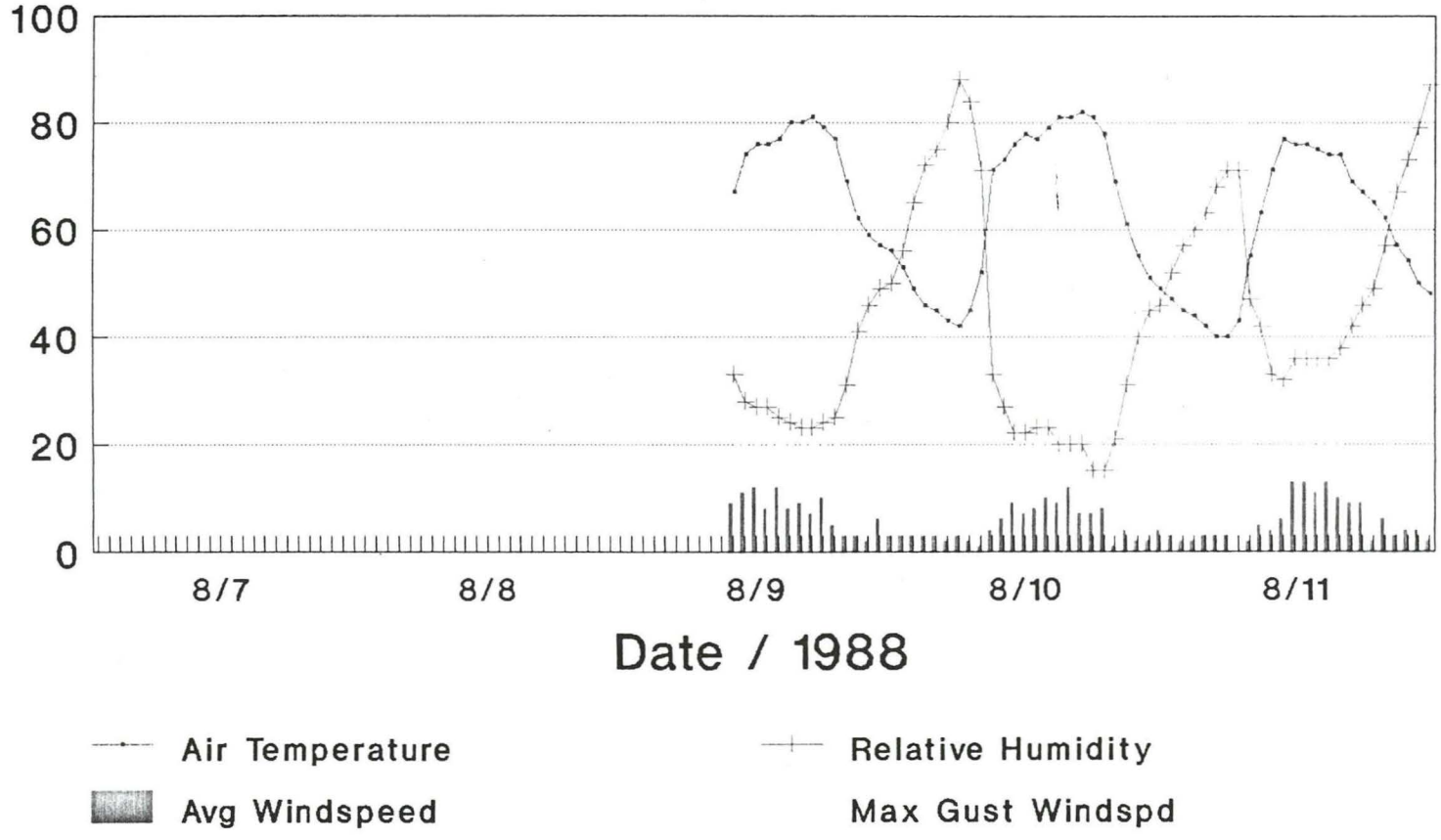


Figure 64. Benchmark RAWS Station air temperature and relative humidity, average wind speed, and maximum gust wind speed measurements for August 7 - August 11, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)



RAWS Fire Weather: Monture 24 hr temperature range: insuff. data
Monture 24 hr relative humidity range: insuff. data
(Monture 1400 hrs readings; no data)
Benchmark 24 hr temperature range: no data
Benchmark 24 hr relative humidity range: no data
Benchmark 24 hr average 20 ft wind speed range (MPH):nodata
(Benchmark 1346 hr readings; no data)

Fire Behavior: Monitoring indicated that the fire was burning upslope on the east slope of Lake Mountain near the ridge and was burning in heavy ABLA timber types. A lack of any definitive topographic or vegetative feature south of Lake Mountain indicated this was the most probable area for the fire to escape. Similar burning, though undocumented, was probably occurring on the ridges above the fire's origin and on Mineral Mountain and at various locations within the upper reaches of the Blackfoot River. No real expansion of the fire perimeter was mapped for this date.

0800 hrs. "Light activity on fire. Thick, coppery blanket smoke throughout fire socking in valley bottoms east as far as Pyramid Peak range." (Silver King Lookout radio log.) [Note; Pyramid Peak is approximately 5 miles east of current fire position.]

1500 hrs. "Little or no activity on fire." (Silver King Lookout radio log.)

Regional Weather: Considerable cloudiness and scattered showers over the eastern portion of the Region during the morning. Glasgow and Miles City reported showers at 0400 hrs. Skies were generally clear over western areas where a high pressure ridge was building. Winds in eastern Montana were 10 to 20 MPH, light elsewhere. Morning temperatures dropped into the upper 30's in the higher southwestern valleys. Most readings were in the 40's in the west and the 50's in the east. At 0500 hrs temperatures ranged from 37 at Butte to 57 at Miles City. By the afternoon the showers in eastern Montana had mostly ended and weak high pressure had spread across the Region bringing mostly sunny skies. Afternoon temperatures were in the high 70's to high 80's, ranging from 76 at Miles City to 91 at Thompson Falls. A few areas had 10 to 25 MPH winds. Winds in Missoula between 1900 and 2100 hrs did gust to between 15 and 30 MPH (Bushey, 1989).

AUGUST 9 (Julian Date 222)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 62.3
Seeley Lake Ranger Station; 3-day running mean ERC: 45.6
Gleason's Resort; 3-day running mean ERC: 53.6

The Lincoln Ranger Station will remain above the ERC 90th percentile level as determined with the Fire Management Plan for the fire season (ERC = 62) for two days before briefly slipping back down.

The east side NFDRS station, Gleason's Resort, had been above the ERC 80th percentile level (ERC = 35) based on the 1973-1987 seasons since July 12. The ERC 90th percentile level (ERC = 40) was reached on July 20th, and the 97th percentile level (ERC = 48) on July 26th. Levels above the 80th and 90th percentiles would be maintained at this station until September 11th.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 8.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.6%
Gleason's Resort; 3-day running mean 10 Hr: 12.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.3%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: no data
Monture, 24 hr High-Low range, 10 Hr fuel: no data
Benchmark, 24 hr High-Low range, 1 Hr fuel: 11-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 11-7%

BEHAVE Fuel Moisture:
(West Zone) no data
(East Zone) 24 hr High-Low range, 1 Hr fuel: 17-6% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 7-6%

RAWS Fire Weather: Monture 24 hr temperature range: no data
Monture 24 hr relative humidity range: no data
(Monture 1400 hrs readings; no data)
Benchmark 24 hr temperature range: 56-81F
Benchmark 24 hr relative humidity range: 23-50%
Benchmark 24 hr average 20 ft wind speed range (MPH): 2-12
(Benchmark 1346 hr readings; 80F, 24%, 8 MPH)

Fire Behavior: Fire activity started to pick up approximately 1430 hrs, by 1450 hrs convection columns were evident. Between 1500-1530 hrs cold but charred debris up to 3 inches in diameter were falling in the vicinity of the Carmichael Guard Station at the junction of the North Fork of the Blackfoot River and Cooney Creek. At this time the fire was burning in the Blackfoot River drainage and on adjacent timbered slopes. Fire spread was to the east and northeast and was hooking around slopes and up timbered drainages such as Theodore Creek. A 35 knot (40.2 MPH) wind was being created by the fire, while free air winds were approximately 20 - 25 knots (23 - 28.7 MPH). Spot fires were being started mostly up to 1/8 of a mile in front of the fire with occasional spots up to a 1/4 mile. Maximum calculated spotting distance for 10 to 15 MPH winds for this fire was 0.3 - 0.4 miles. Increasing the wind speed range to 20 - 30 MPH increased the spotting distance from 0.5 to 0.8 miles. By 1900 hrs the fire had hit the Continental Divide at the head of Tobacco Valley and had thrown burning embers an estimated 1/2 mile into the heads of Bald Bear Creek and Upper Twin Creek on the east side of the Divide. Calculation of maximum spotting distance from this crown fire run at the ridgetop of the Continental Divide indicate a distance of 0.6 - 0.8 miles with a 20 to 30 MPH wind speed. These spot fires smoldered with limited creeping of flames (Sisk interview). The fire traveled approximately 5 1/2 miles up the Tobacco Valley between 1530 and 1900 hrs, averaging a rate-of-spread of 126 chains/hr (1.57 miles/hr) as the fire moved through the lodgepole crown. These observations closely match calculations for the crown fire run which indicated a range of about 0.9 - 2.2 miles/hr rate-of-spread, unit energy of 4,250 BTU/FT^2, and flame lengths of 60 - 120 ft above the canopy (75% confidence interval). The average rate-of-spread calculated would have been an approximate range of 1.0 - 1.9 miles/hr, and a potential maximum spread of about 3.0 miles/hr. The crown

fire run was marginal between being driven by the wind and being a blow-up fire driven by the power of the fire; with a Unit Power of Wind range of 20 - 90, and the Unit Power of Fire (30 - 60)(Rothermal, 1991)(figure 65). This produces a ratio of 1.5 at the low end of the wind speed range and the crown run being driven by the power of the fire, at the upper end of the wind speed the ratio was 0.7 indicating a wind driven fire. In most cases the fire closely followed the drainage, burning to the adjacent ridge tops and just crossing the lower mouths of drainages feeding into the Tobacco Valley and the upper stretches of the North Fork of the Blackfoot River. Insufficient information is available to determine the Probability of Ignition west of the Continental divide on this date. East of the divide the Probability of Ignition ranged from 40 - 50% during the afternoon at the elevation at which the firebrands were tossed. The fire was reported to have reached 33,000 acres of which about 300 acres were on the Lewis & Clark National Forest in two different drainages: Bald Bear and Upper Twin Creeks (USDA Northern Region, 1989). Digitized mapping of the fire perimeter set the within perimeter fire acreage as 32,148 acres with an additional 7,743 acres being included on this date, all in the vicinity of Tobacco Valley.

0700 hrs. "Partly cloudy - clear, 48 degrees, winds gusty west 10-12 MPH. No activity on fires." (Silver King Lookout radio log.)

1430 hrs. "Moderate activity on Lake Mountain. Winds west 10-12 MPH." (Silver King Lookout radio log.)

1445 hrs. "Canyon Fire is burning hot today. About a mile from Carmichael Cabin." (Lolo National Forest, Fire Dispatch radio log.)

1450 hrs. "Three separate columns." (Silver King Lookout radio log.)

1500 hrs. "Largest column, northeast drift, north of Olson Peak, plume 14,000' elevation." (Silver King Lookout radio log.) [Note; Tobacco Valley was approximately 3 miles north of Olson Peak.]

1531 hrs. "Canyon column to 20,000 feet, impressive!" (Aerial patrol to Rocky Mountain District, Lewis and Clark National Forest, radio log.)

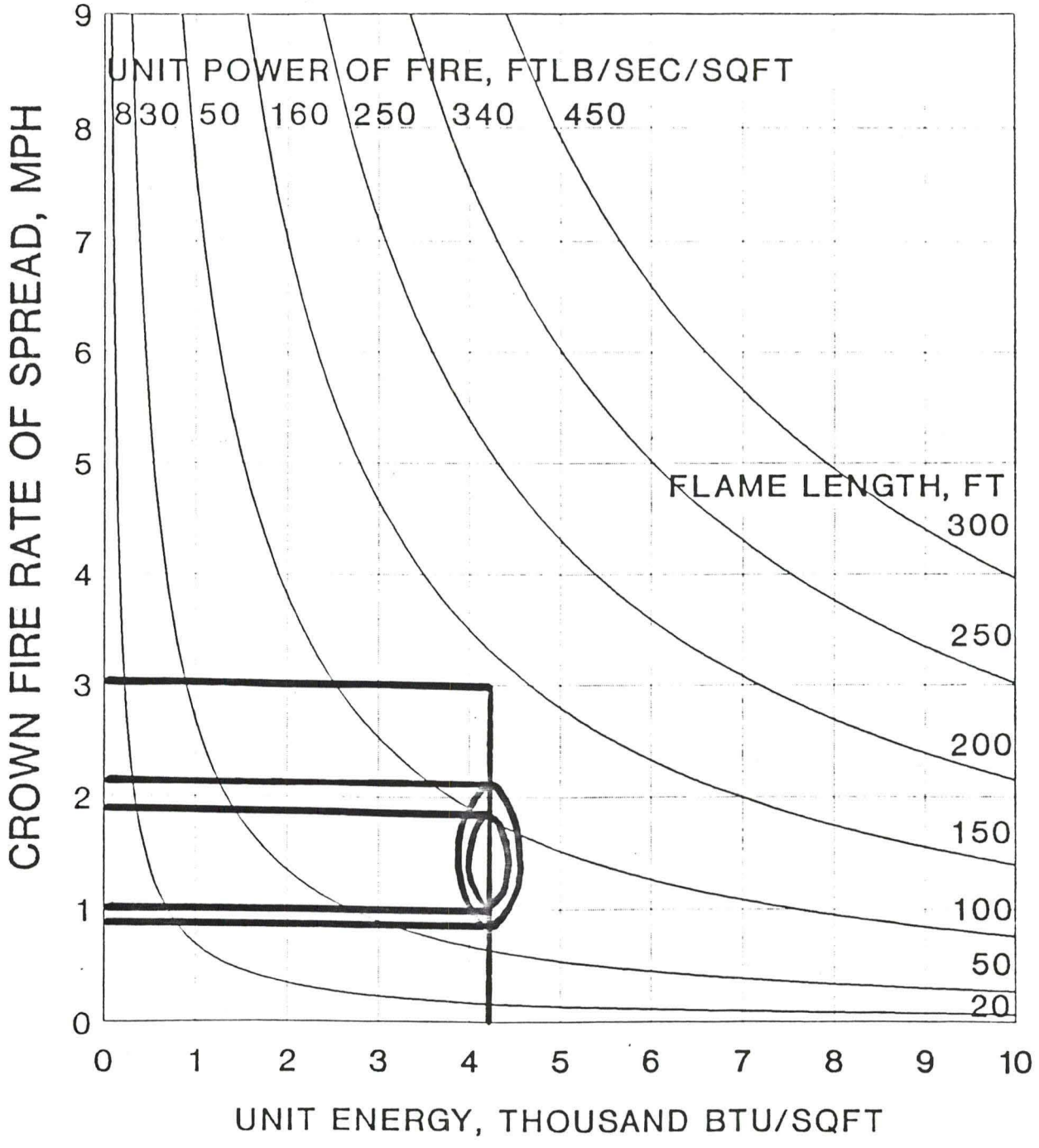
1535 hrs. "WB 47, DB 68, RH 19%, winds erratic west / northwest 15-20 MPH." (Silver King Lookout radio log.)

1600 hrs. "Canyon Creek Fire in Tobacco Valley." (Aerial patrol to Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1700 hrs. "DB 68, WB 48, RH 22%, wind erratic southwest / west 8-20 MPH. Four large columns. Can see Warm Springs smoke." (Silver King Lookout radio log.) [Note; the Warm Spring Creek Fire was started by a catalytic converter on a jeep and was located approximately 50 miles southeast of Silver King Lookout and to the southwest of Helena.]

1735 hrs. "Gate's blowup." (Silver King Lookout radio log.)

Figure 65. Detail from the Crown Fire Nomogram (Rothermel, 1991) for the August 9, 1988 fire behavior in Tobacco Valley during the Canyon Creek Fire.


CROWN FIRE RATE OF SPREAD, MPH
UNIT ENERGY, THOUSAND BTU/SQFT
UNIT POWER OF FIRE, FTLB/SEC/SQFT
8 30 50 160 250 340 450
FLAME LENGTH, FT
300
250
200
150
100
50
20
0
1
2
3
4
5
6
7
8
9
10

1745 hrs. "Look at column from Canyon Creek!!" (Beartop Lookout to Rocky Mountain District, Lewis and Clark National Forest, radio log.) [Note; Beartop Lookout was just to the east of the Gates Park Wilderness Prescribed Fire]

1900 hrs. "DB 65, WB 47, RH 25%, wind west / northwest 10-14 MPH." (Silver King Lookout radio log.)

2000 hrs. "DB 67, WB 47, RH 21%, winds west / northwest 10-14 MPH and erratic. Canyon fires calming down. Warm Springs Fire kicking up, good column." (Silver King Lookout radio log.)

2100 hrs. "DB 60, WB 45, RH 31%, wind west 10-14 MPH." (Silver King Lookout radio log.)

Regional Weather: Skies were mostly cloudy across western Montana after sunset, but by midnight had cleared. Skies in the east were clear to partly cloudy. Winds were generally 15 MPH or less. Morning low temperatures ranged from the mid-30's in the southwest to the high 50's in the east. The coolest location was West Yellowstone at 37, the warmest was Miles City with 59. Gusty winds developed in the afternoon as a weak upper level disturbance moved through southern portions of British Columbia and Alberta. As the system moved east winds gusted to 30 to 40 MPH in many areas. In Missoula gusts were recorded up to 35 MPH. Sunny skies prevailed across the Region and temperatures were unseasonally warm. Most afternoon high temperatures were in the upper 80's and low 90's, ranging from 80 degrees at West Yellowstone to 98 at Hardin. Yellowstone National Park reported high temperatures ranging from 73 to 83 with afternoon humidities between 12 and 19%. Their winds were from the southwest to west, 10 to 15 MPH and occasional gusts to 25 MPH. A few broken clouds moved into the northwest corner of Yellowstone National Park during the evening (Bushey, 1989).

AUGUST 10 (Julian Date 223)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 64.6
Seeley Lake Ranger Station; 3-day running mean ERC: 46.3
Gleason's Resort; 3-day running mean ERC: 55.3

The Lincoln Ranger Station on this date exceeded the ERC 97th percentile level (ERC = 63) as determined from the 1973-1987 seasons. The levels will drop on the next day below the 90th percentile levels as determined by both the Fire Management Plan (ERC = 62), and within three days below the 90th as determined by the 1973-1987 seasons (ERC = 56).

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 8.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.0%
Gleason's Resort; 3-day running mean 10 Hr: 10.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 7-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 12-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 26-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 22-7%

BEHAVE Fuel Moisture:

(West Zone) 24 hr High-Low range, 1 Hr fuel: 9-5% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
24 hr High-Low range, 1 Hr fuel: 10-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6-5%

(East Zone) 24 hr High-Low range, 1 Hr fuel: 14-6% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6%

RAWS Fire Weather: Monture 24 hr temperature range: 60-86F
Monture 24 hr relative humidity range: 19-43%
Monture 24 hr average 20 ft wind speed range (MPH): 2-12
(Monture 1500 hrs readings; 83F, 20%, 8 MPH)
Benchmark 24 hr temperature range: 38-82F
Benchmark 24 hr relative humidity range: 15-88%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-12
(Benchmark 1346 hr readings; 81F, 20%, 9 MPH)

Fire Behavior: Thermal belt conditions were being observed in the mountains causing very active burning in some locations to continue in to the night hours. Fire activity started to pickup about 1200 hrs and continued until about 2000 hrs when fire behavior decreased. Peak burning period Probability of Ignition ranged from 50 - 60%.

Most of the fire activity on this date occurred within previously burned perimeters, not causing any expansion of the burned boundary. Spot fires thrown over the Continental Divide from the previous days run in the Tobacco Valley were generally inactive, but smoking and smoldering and slowly burning downslope (Sisk interview, Youngquist interview). It took a little while but by the end of the afternoon the burned area and spot fires on the east side of the divide were eventually determined to be about 200 acres. At the elevation these East Zone spot fires were burning the Probability of Ignition during the peak afternoon burning conditions was 50%. No new expansion of the fire perimeter was mapped on this date.

0700 hrs. "Clear, 55 degrees, winds west / northwest 10-16 MPH. No activity on fires." (Silver King Lookout radio log.)

1200 hrs. "Fire on our side of the divide." (Augusta Information Station radio log.) [Note; spot fires from the previous days run in Tobacco Valley were burning in the heads of Bald Bear Creek and Upper Twin Creek drainages.]

1202 hrs. "No activity on fires north, plenty on Warm Springs." (Silver King Lookout radio log.)

1230 hrs. "Canyon Fire has activity west slope mid 1/2 of mountain and on delta branch of Mineral Hill north slopes." (Silver King Lookout radio log.) [Note; Mineral Mountain to the northeast of Mineral Hill.]

1320 hrs. "Wind change south / southwest 14-23 MPH." (Silver King Lookout radio log.)

1440 hrs. "Winds southwest / west 14-16 MPH gusting to 18, RH at 1400 hrs was 24%. Most southerly column is the most active, east of Blackfoot River, west ridge of the northerly slope on Mineral Hill (Mineral Mountain)." (Silver King Lookout radio log.)

1645 hrs. "300-400 acres on the Lewis and Clark" National Forest. (Augusta Information Station radio log.)

1700 hrs. "Two columns, one north end of Canyon, second is Gates Fire. DB 68, WB 46, RH 16%, wind west 10-16 MPH." (Silver King Lookout radio log.)

1725 hrs. "Burning on east side of the North Fork, torching and crowning. Would like someone to take a look at it." (Lolo National Forest, Fire Dispatch radio log; transmission from North Fork Bridge Crew)

1800 hrs. "Dave (Sisk) says at this time approximately 200 acres have burned on Lewis and Clark (National Forest)." (Lolo National Forest, Fire Dispatch radio log.)

1845 hrs. "Mushroom cloud in the Scapegoat...as usual. How is North Fork Cabin doing?" (Lolo National Forest, Fire Dispatch radio log; transmission from Stark Mountain Lookout)

1900 hrs. "DB 66, WB 44, RH 13%, wind northwest / west erratic 14-20 MPH." (Silver King Lookout radio log.)

2000 hrs. "Activity on fires down. Thick, coppery colored blanket smoke. DB 65, WB 45, RH 19%, wind northwest 10-18 MPH." (Silver King Lookout radio log.)

Regional Weather: Skies were mostly clear across the Region except for some high cloudiness in the southcentral sections which persisted after dawn as the airmass continued quite warm and dry. Night and morning winds were generally 15 MPH or less with most stations reporting less than 10 MPH. Low temperatures ranged from the low 40's in the southwest to the high 60's in the southcentral areas, and ranged from 41 at West Yellowstone to 68 at Billings. During the afternoon hot, dry winds began blowing across some areas of Montana. Winds were erratic in the 15 to 30 MPH range and mostly from the northwest to northeast. The winds helped to push the relative humidity to below 20% in most areas. Isolated thunderstorms from Idaho began pushing northward into southwest Montana during the late afternoon with increased cloudiness extending into central portions of the Region. At 1500 hrs a line of thunderstorms from Pocatello-Big Piny were moving north toward Yellowstone National Park. It was smokey across most of Montana during the afternoon. High afternoon temperatures were mostly in the 90's, West Yellowstone was the coolest location at 83 and the warmest were Broadus and Miles City at 97 and Glendive at 100 (Bushey, 1989).

AUGUST 11 (Julian Date 224)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 60.3
Seeley Lake Ranger Station; 3-day running mean ERC: 46.3
Gleason's Resort; 3-day running mean ERC: 55.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 13.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.0%
Gleason's Resort; 3-day running mean 10 Hr: 9.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 13-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 19-6%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 17-6%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 16-9%

BEHAVE Fuel Moisture:
(West Zone) 24 hr High-Low range, 1 Hr fuel: 9-5% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
24 hr High-Low range, 1 Hr fuel: 10-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6-5%
(East Zone) 24 hr High-Low range, 1 Hr fuel: 14-8% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 9-8%

RAWS Fire Weather: Monture 24 hr temperature range: 50-86F
Monture 24 hr relative humidity range: 18-59%
Monture 24 hr average 20 ft wind speed range (MPH): 1-16
(Monture 1400 hrs readings; 83F, 20%, 9 MPH)
Benchmark 24 hr temperature range: 40-77F
Benchmark 24 hr relative humidity range: 32-71%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-13
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):6-27
(Benchmark 1346 hr readings; 74F, 36%, 13 MPH gusts to 27)

Fire Behavior: The Canyon Creek Fire was relative inactive (Bonney, 1988). No new perimeter growth noted on this date as increased relative humidity arrived. Probability of Ignition on this afternoon was similar to the previous afternoon in the West Zone, 50 - 60%. East of the Continental Divide at the elevation of the spot fires from the Tobacco Valley crown fire run the Probability of Ignition was only 30 - 40%.

0700 hrs. "Clear, calm, 57 degrees. No activity on fires." (Silver King Lookout radio log.)

0837 hrs. "Lightning west side of Garnets [Note; mountain range 35 miles to the southwest.], Ogden, Stemple ridges, divide area Nevada/Black Mountains [Note; approximately 30 miles to the south] south and east along the divide toward Rodgers Mountain [Note; approximately 17 miles southeast.]." (Silver King Lookout radio log.)

1445 hrs. "Wind change, erratic north / northeast / east 10-14 MPH and gusty. Building cumulus to southwest / south / southeast could produce lightning anytime. Smaller (thunderstorms) building to west / north / northwest. Temperature 68 degrees. Light activity on fire." (Silver King Lookout radio log.)

1530 hrs. "Storm courses entire district from west to east moving northeast, presently south of Silver King. Heavy rain." (Silver King Lookout radio log.)

1620 hrs. "Visibility poor to southwest / west, can see Blackfoot River bottom only (looks like rain?). Clouds black, no lighting yet. Activity increasing in Canyon Fire. Winds erratic east / northeast / north 12-18 MPH, 62 degrees." (Silver King Lookout radio log.)

1801 hrs. "Storm moving east over divide, quite a bit of ground fog in area." (Silver King Lookout radio log.)

1856 hrs. "Willow Creek Reservoir - light rain, nothing north of Gibson" Reservoir. (Augusta Information Station radio log.)

1900 hrs. "Lightning south of Silver King and along the divide to the east." (Silver King Lookout radio log.)

1925 hrs. "Private aircraft reported fire on Blowout Mountain, 235 degrees at 50 miles." (Augusta Information Station radio log.) [Note; an aerial observer checked the vicinity and could not find a fire.]

1945 hrs. "Raining, third storm overhead, no lightning yet. Can see smoke from Arrastra, 262 degrees 30', over low ridge between Red-Stonewall Mountains." (Silver King Lookout radio log.)

2120 hrs. "Received .02" precipitation." (Silver King Lookout radio log.)

Miscellaneous: Lightning storm ignites several fires on the Lincoln Ranger District within the Scapegoat Wilderness. The Arrastra Mountain Fire burns 5 ac before being controlled. The Echo Mountain Fire was put into confine strategy and the Iron Mountain Fire was not found for about 1 week and was controlled by a crew of 3 (Bonney, 1988). [Note; all three fires were within the Scapegoat Wilderness.] The Dunham Fire started on the Seeley Lake District about 9 miles west of Canyon Creek Fire (would eventually reach 65 acres before being suppressed). Several other lightning fires in the vicinity were suppressed at less than 1 acre (USDA Northern Region, 1989).

Regional Weather: A weak Canadian cold front extended from a low pressure system through South Dakota and central Montana this morning. There were a few scattered thunderstorms across the Region during the night, these were mostly dry. Low morning temperatures ranged from 37 at West Yellowstone to 74 at Miles City. Considerable thunderstorm activity developed over the Region during the afternoon, mostly dry with lots of lightning and strong gusty winds. Some of the heaviest thunderstorm activity was experienced over the Clearwater, Beaverhead, Helena, Lewis and Clark, and Custer National Forests. During the afternoon and evening 4,028 discharges were recorded. Wind gusts from 25 to 43 MPH were common with these thunderstorms. Winds gusted to 44 MPH at Butte and to 46 MPH at Helena around 1700 hrs. Earlier in the afternoon Salmon, Idaho reported gusts to 52 MPH. In Yellowstone National Park afternoon thunderstorms occurred near the south entrance moving north-northeast. Another band of storms was occurring just north of the Park in southern Montana. These thunderstorms were part of a much larger mass of dry lighting which reached in an arc from northern California up toward Pendelton, Oregon and over into the Bitterroot Valley of Montana. This system then extended through Glendive in

the northeastern portion of the Region into Canada. Afternoon temperatures were mostly in the 90's; ranging from 75 at Cutbank, 84 at Wisdom and West Yellowstone to 100 degrees at Hardin. It was smokey over much of the Region during the afternoon. The thunderstorms ended in most areas by midnight (Bushey, 1989).

Long-Range Weather Forecast: Three to five day outlook from the NWS called for continued warm and dry with isolated thunderstorm activity likely. High temperatures were expected to be 80 to 90, lows mostly in the 40's and 50's. The six to ten day outlook indicated temperatures above normal, precipitation below normal (Bushey, 1989).

AUGUST 12 (Julian Date 225)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 57.6
Seeley Lake Ranger Station; 3-day running mean ERC: 46.0
Gleason's Resort; 3-day running mean ERC: 53.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.3%
Gleason's Resort; 3-day running mean 10 Hr: 11.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 18-6%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-5%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 26-11%

BEHAVE Fuel Moisture:
(West Zone) Insufficient data
(East Zone) 24 hr High-Low range, 1 Hr fuel: 14-9% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 10-9%

RAWS Fire Weather: Monture 24 hr temperature range: 50-88F
Monture 24 hr relative humidity range: 18-46%
Monture 24 hr average 20 ft wind speed range (MPH): 1-9
(Monture 1400 hrs readings; 84F, 18%, 7 MPH)
Benchmark 24 hr temperature range: 40-80F
Benchmark 24 hr relative humidity range: 25-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-13
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):4-31
(Benchmark 1346 hr readings; 80F, 25%, 13 MPH gusts to 31)
(figures 66 - 69)

Fire Behavior: A return to slightly less humid conditions took place during the day on the west side of the divide, the east side stayed more humid. The Probability of Ignition on the East Zone spot fires stayed low only reaching a maximum value of 30%. Only scattered burning of surface fuels was occurring. No new increases in perimeter size noted for this day. A Tactical Team arrived on the spot fires which had been thrown over the Continental Divide at the head

Figure 66. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for August 12 - August 16, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

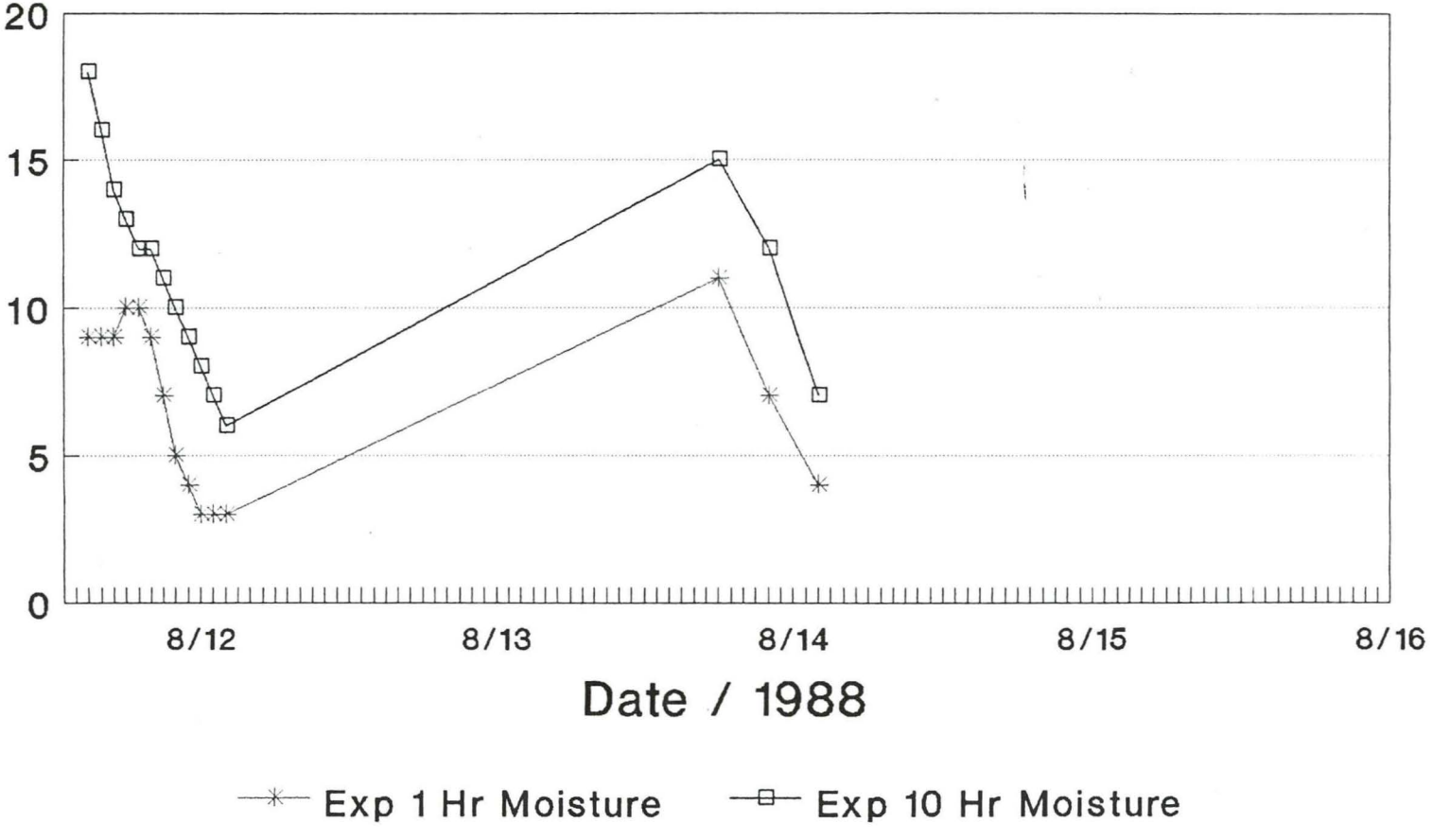


Figure 67. Monture RAWS Station air temperature and relative humidity measurements for August 12 - August 16, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

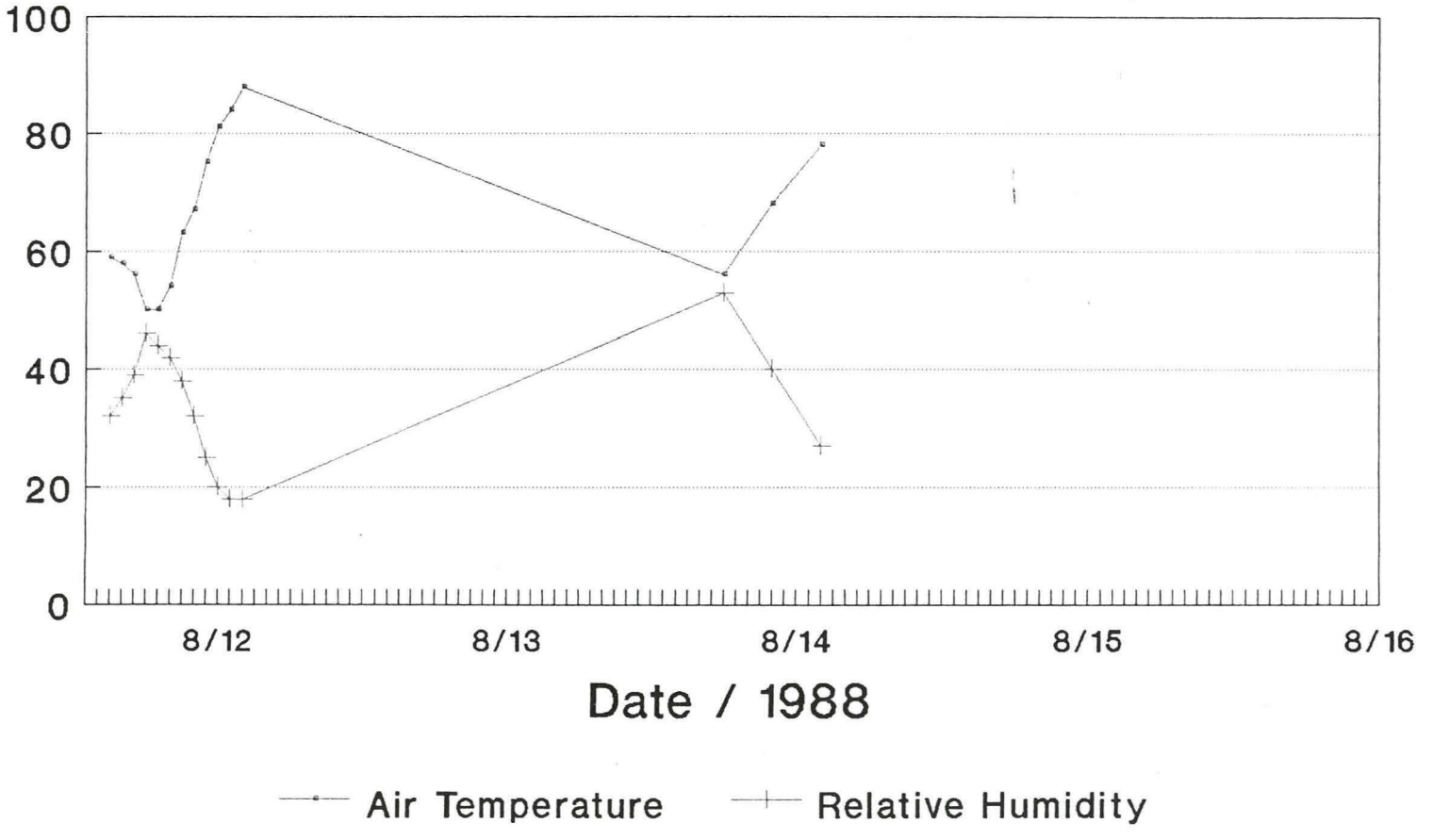


Figure 68. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and precipitation measurements for August 12 - August 16, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)

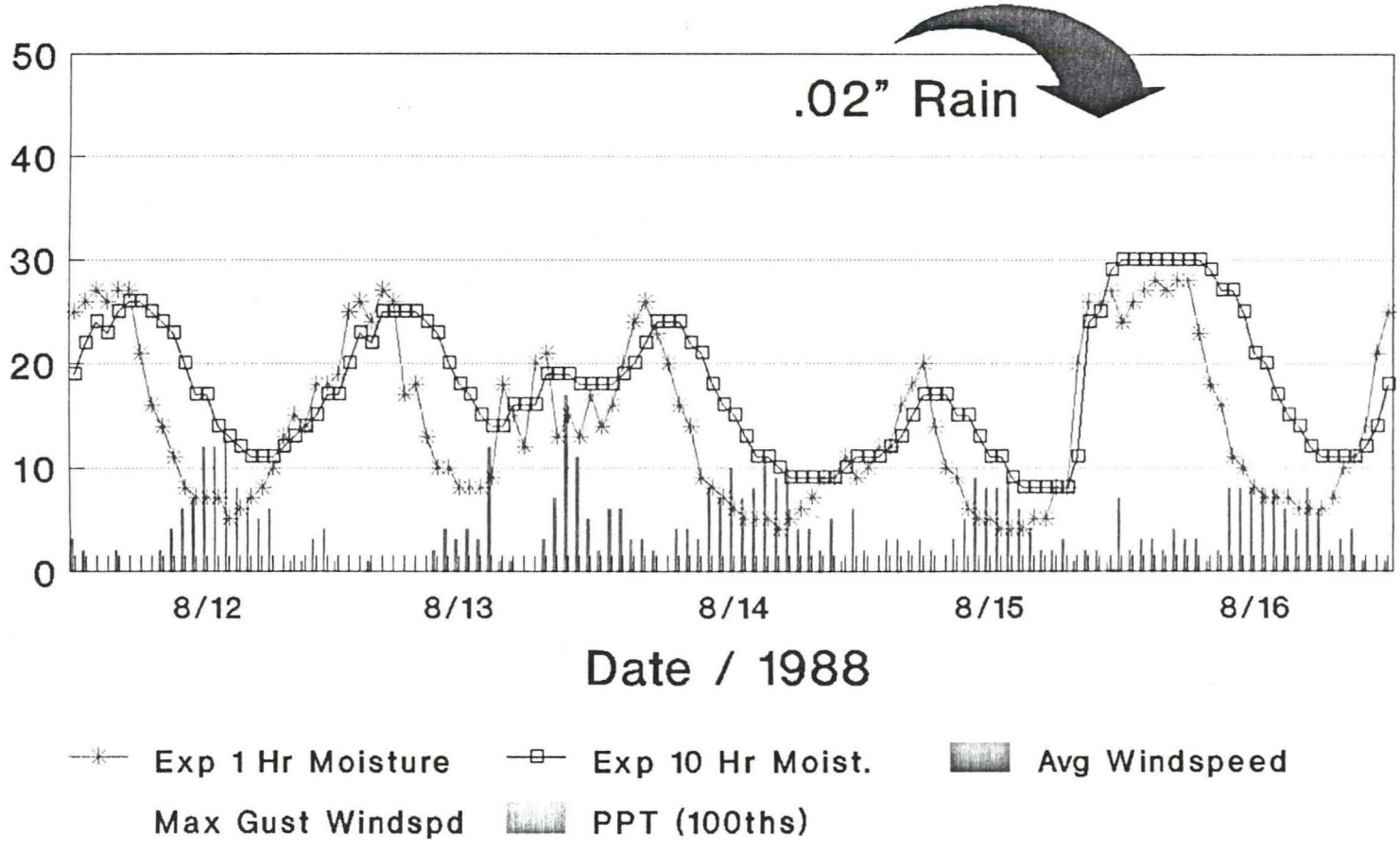
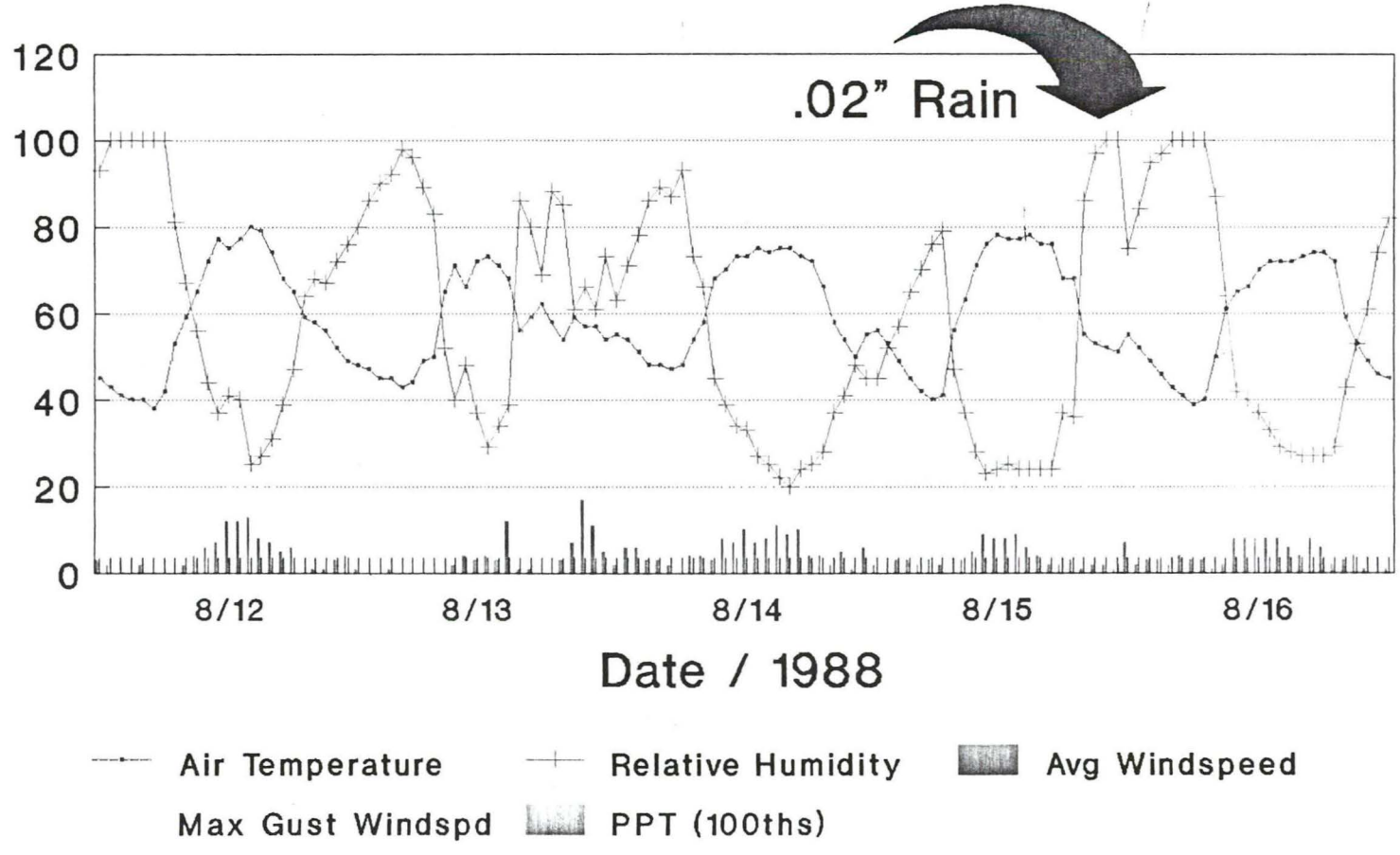


Figure 69. Benchmark RAWS Station air temperature and relative humidity, average wind speed, maximum gust wind speed, and precipitation measurements for August 12 - August 16, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)



of Tobacco Valley. This team started blasting fireline to restrict spread of the spots and in preparation of doing some burnout operations to keep all fire east of the Dearborn River. Additional action in this vicinity included water drops and the placement of water pumps in the river.

0700 hrs. "Temperature 51 degrees, winds southwest 5-10 MPH. Partly cloudy with some building cumulus." (Silver King Lookout radio log.)

1528 hrs. "Gusty winds, draw to south." (Transmission from Dave Thomas during preparation for fireline blasting on the east side of the divide, Augusta Information Station radio log.)

1600 hrs. "Wind south 14-16 MPH, gusting to low 20's." (Silver King Lookout radio log.)

1625 hrs. "Swing by fire and see what its doing. Not doing anything." Helibase to aerial observer. (Augusta Information Station radio log.)

1727 hrs. "Done blasting,...very little winds." Helibase. (Augusta Information Station radio log.)

1844 hrs. "Winds out of west 2-3 miles." Helibase. (Augusta Information Station radio log.)

Regional Weather: Morning low temperatures were mostly in the 50's and 60's with the cooler locations in the high western valleys. Drummund was the coolest spot with 42 degrees, and Kalispell the warmest location this morning at 63. During the afternoon considerable cloudiness developed across the region from an area of moist, unstable air off of the California coast which was moving to the northeast. Rainfall was spotty with lightning and strong gusty winds common in the vicinity of the heavier buildups. Widespread shower and thunderstorm activity occurred in Yellowstone National Park as a weak upper level disturbance moved over the area. Temperatures warmed in the northwest portion of the Region, while some southern areas had considerable cooling. For example, yesterday Thompson Falls reported a high of 96 and climbed to 101 today, while down in Dillon they only reached 68 today compared to 84 yesterday. These stations had the high and low maximum temperatures for the day. Broadus was the only regular reporting station that had reported any significant precipitation by the late afternoon (.40"), but scattered showers continued into the night and early next morning (Bushey, 1989).

AUGUST 13 (Julian Date 226)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 53.5
Seeley Lake Ranger Station; 3-day running mean ERC: 45.0
Gleason's Resort; 3-day running mean ERC: 51.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 18.5%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 6.3%
Gleason's Resort; 3-day running mean 10 Hr: 13.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: no data
Monture, 24 hr High-Low range, 10 Hr fuel: no data
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-8%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 25-14%

BEHAVE Fuel Moisture:
(West Zone) No data
(East Zone) 24 hr High-Low range, 1 Hr fuel: 23-7% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 7%

RAWS Fire Weather: Monture 24 hr temperature range: no data
Monture 24 hr relative humidity range: no data
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1400 hrs readings; no data)
Benchmark 24 hr temperature range: 43-73F
Benchmark 24 hr relative humidity range: 29-98%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-12
Benchmark 24 hr temperature range: 40-77F
Benchmark 24 hr relative humidity range: 32-71%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-13
(Benchmark 1346 hr readings; 68F, 39%, 12 MPH)

Fire Behavior: Weather conditions over the fire stayed cloudy and cool with scattered rains. East Zone probability of Ignition during the afternoon reached 50% in the area of the spot fires. No increase in fire perimeter on this date with only low intensity burning occurring within the perimeter.

0700 hrs. Partly cloudy, high to middle clouds, 51 degrees, winds northwest 10-16 MPH. Blanket smoke on Canyon Fire." (Silver King Lookout radio log.)

0712 hrs. "No rain; partly cloudy." (Transmission from Welcome Creek Guard Station to the Augusta Information Station, radio log.)

0945 hrs. "Spot Weather: elevation 7300, winds 0-3 MPH downslope, DB 60, WB 51, scattered cumulus clouds. (Transmission from Youngquist to the Augusta Information Station, radio log.)

1230 hrs. "Raining hard; rain in from west." (Transmission fronm the Elk Creek Division Fire Camp to the Augusta Information Station, radio log.)

1230 hrs. "Lightning east of the divide on the Lewis and Clark National Forest. Winds southwest 8-14. (Thunderstorm) Cells around tower." (Silver King Lookout radio log.)

1242 hrs. "Elk Creek a hard rain; Welcome Creek no rain but overcast; doesn't look like the fire is getting anything." (Augusta Information Station radio log.)

1245 hrs. "Is now raining." (Transmission from Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1255 hrs. "Rain quite at Welcome Creek." (Augusta Information Station radio log.)

1403 hrs. "Storms over Lincoln." (Silver King Lookout radio log.)

1538 hrs. ".20" moisture in Elk Creek." (Augusta Information Station radio log.)

1539 hrs. "Table Mountain, nothing but water dogs." (Transmission from an aerial observer to the Augusta Information Station, radio log.)

1541 hrs. "Heavy precipitation, flying up Dearborn now." (Transmission from an aerial observer to the Augusta Information Station, radio log.)

2000 hrs. "Storm moving in Lincoln Valley, looks like it has rain." (Silver King Lookout radio log.)

2100 hrs. "Shutting down radio due to intense lightning." (Silver King Lookout radio log.)

2200 hrs. "Moderate rain, constant." (Silver King Lookout radio log.)

Regional Weather: A few widely scattered thunderstorms lingered through the night. Winds were light in most areas and generally less than 15 MPH. Low morning temperatures were mostly in the 50's and low 60's, ranging from 45 at Drummond to 69 at Havre. Afternoon thunderstorms and showers moved through central and southern Montana. Some of these showers were locally heavy, Missoula received .21". Gusty thunderstorm winds in Billings were briefly up to 46 MPH, and at Missoula up to 51 MPH. Afternoon temperatures were mostly in the 80's, and ranged from 80 degrees at West Yellowstone to 93 at Thompson Falls. An upper air, low pressure trough existed over the Pacific west coast. Ahead of this trough a warm, moist southerly airflow was occurring over Idaho and western Montana (Bushey, 1989).

Long-Range Weather Forecast: Three to five day outlook for the Region was to return to warm and dry by the 16th with temperatures in the upper 80's by the 17th. The six to ten day outlook indicated near normal temperatures with below normal precipitation (Bushey, 1989).

Miscellaneous: The Palmer Drought Severity Index remained essentially unchanged with most of the Region in extreme drought, except for moist northern Idaho (Bushey, 1989).

AUGUST 14 (Julian Date 227)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 58.5
Seeley Lake Ranger Station; 3-day running mean ERC: 44.6
Gleason's Resort; 3-day running mean ERC: 50.6

The Lincoln Ranger Station again moves above the ERC 90th percentile level (ERC = 56) based on the 1973-1987 seasons and would remain above this level until September 10th.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 13.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 7.0%
Gleason's Resort; 3-day running mean 10 Hr: 14.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 11-4%
Monture, 24 hr High-Low range, 10 Hr fuel: 15-7%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 26-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 24-9%

BEHAVE Fuel Moisture:
(West Zone) Insufficient data
(East Zone) 24 hr High-Low range, 1 Hr fuel: 16-6% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 7-6%

RAWS Fire Weather: Monture 24 hr temperature range: 56-78F
Monture 24 hr relative humidity range: 27-53%
Monture 24 hr average 20 ft wind speed range (MPH): 4-52
(Monture 1500 hrs readings; 78F, 27%, 5 MPH)
Benchmark 24 hr temperature range: 47-75F
Benchmark 24 hr relative humidity range: 20-89%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-11
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):4-28
(Benchmark 1346 hr readings; 74F, 25%, 8 MPH gusts to 28)

Fire Behavior: Relative humidities stayed high on both sides of the divide, keeping fire activity to a minimum. Again, on the East Zone the Probability of Ignition achieved 50% during peak afternoon burning conditions. No expansion of the fire perimeter was mapped.

0745 hrs. "Clear visibility, ground fog in Landers Fork and east in valleys. .15" precipitation." (Silver King Lookout radio log.)

Regional Weather: The upper air trough was slowly moving inland from the Pacific west coast with warm, unstable southerly flow ahead of it. A Red Flag was issued for the Yellowstone area for strong winds and low humidities. Morning low temperatures mostly ranged in the 50's and low 60's, with West Yellowstone being the coolest location at 33 degrees and Drummond the warmest with 67. During the previous 24 hour period (0600-0600) there were 4688 lightning strikes across the Region, mostly concentrated on the Nez Perce,

Lolo, Helena, Lewis and Clark National Forests and lands to the northeast of Billings. Significant moisture was received in the Missoula-Superior-Helmville area from a thunderstorm which moved out of the Selway-Bitterroot Wilderness with .51" recorded by RAWS at both Superior and Ninemile. During the day there were clear to partly cloudy skies and widely scattered thundershowers. Afternoon temperatures ranged from a high of 76 degrees at Wisdom to 99 at Broadus, Glendive, and Miles City. Most locations were in the 80's and 90's. Humidities in Yellowstone National Park during the afternoon dropped into the lower teens with winds in the 15 to 25 MPH range. The strongest gust measured during the afternoon was 38 MPH at Thorofare in the southeastern portion of the Park (Bushey, 1989).

AUGUST 15 (Julian Date 228)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 59.5
Seeley Lake Ranger Station; 3-day running mean ERC: 43.0
Gleason's Resort; 3-day running mean ERC: 49.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 12.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 8.6%
Gleason's Resort; 3-day running mean 10 Hr: 14.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: no data
Monture, 24 hr High-Low range, 10 Hr fuel: no data
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 29-8%

BEHAVE Fuel Moisture:
(West Zone) No data
(East Zone) 24 hr High-Low range, 1 Hr fuel: 23-8% at 6800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 8%

RAWS Fire Weather: Monture 24 hr temperature range: no data
Monture 24 hr relative humidity range: no data
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1400 hrs readings; no data)
Benchmark 24 hr temperature range: 40-78F
Benchmark 24 hr relative humidity range: 23-76%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-9
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):5-32
(Benchmark 1346 hr readings; 78F, 24%, 6 MPH gusts to 17)

Fire Behavior: Rains of the past weekend had cooled the Canyon Creek Fire for the time being. A few spots around Lake Mountain and a few spots near the Continental Divide on the Lewis and Clark National Forest were all that appeared to remain of the threats that had kept people busy for the last 3 weeks (or at least all that were putting up smoke visible from the air). Lolo sent personnel to mop-up 2 spots south of Lake Mountain. Lewis and Clark National Forest considered mopping-up remaining fire east of the Continental

Divide thereby eliminating any current threat to the wilderness boundary north of the Dearborn river. East Zone Probability of Ignition during peak burning conditions only reached 40%. Although the fire still has the potential to develop into the fall, the chances of anything major appeared to be considerably reduced.

0700 hrs. "Temperature 56 degrees, winds north 5-10 MPH, clear skies. No visible activity on fires." (Silver King Lookout radio log.)

1800 hrs. "Blowup Warm Springs Fire." (Silver King Lookout radio log.)

2115 hrs. "Strikes on Dalton-Ogden (Mountains)." (Silver King Lookout radio log.) [Note; approximately 11 miles southwest of Silver King Lookout.]

2215 hrs. "Shutting down radios due to lighting, getting rain." (Silver King Lookout radio log.)

2230 hrs. "Glow on radio antenna has six inch long static electricity candles off of it. Each corner of the shutters glowing blue (color of arc welders flame)." (Silver King Lookout radio log.)

2235 hrs. "Back in service." (Silver King Lookout radio log.)

2300 hrs. "Winds southwest / west erratic 10-18 MPH gusty. Warm Springs glow massive!" (Silver King Lookout radio log.)

Regional Weather: The upper air trough of low pressure over the Pacific coast was being kept stationary, continuing the south to southwest airflow pattern. A Red Flag Warning was issued for eastern Montana for a frontal passage which was expected to bring high based thunderstorms, dry lightning, gusty winds, and poor humidity recovery. The Yellowstone area remained under a Red Flag Watch for low humidities. Fair skies and light winds prevailed across the Region most of the night. Most stations across the Region had very low to moderate humidity recovery last night. Low temperatures during the morning were mostly in the 50's and 60's and were cooler in the higher southwestern valleys of the Region. West Yellowstone was again the coolest location at 30 degrees and Miles City was the warmest with 62. During the afternoon cloud cover was increasing along the southern border, otherwise skies were clear across the Region. A weak frontal system crossed the Region during the afternoon setting off thunderstorms, wind activity, and slightly cooling the air. Very little lightning activity occurred and most was concentrated over the Nez Perce, Clearwater, Idaho Panhandle National Forests and the upper Bob Marshall Wilderness on the Flathead National Forest. Cutbank recorded some precipitation from a thunderstorm, but elsewhere they were mostly dry. South winds were gusting over 35 MPH at Dillon and winds over 20 MPH were reported at several locations. Winds in the Yellowstone area also remained strong with peak gusts in the vicinity of Thorofare River with gusts to 37 MPH and averaging between 9 to 19 MPH over a nine hour period. Prior to the passage of the dry cold front relative humidities were down to 7% in that area. A RAWS station in the southcentral portion of the Region located near the center of a passing thundercell recorded gusts up to 71 MPH and average wind speeds of 50 MPH, but no rain. Temperatures warmed into the 80's and low 90's by early afternoon. High temperatures for the date ranged from 76 degrees at Libby to 97 at Miles City. During the evening (between 2100 and 2200 hrs) northwest

winds gusting around 45 MPH were reported at Great Falls. Several stations reported winds between 15 and 25 MPH (Bushey, 1989).

AUGUST 16 (Julian Date 229)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 60.0
Seeley Lake Ranger Station; 3-day running mean ERC: 42.3
Gleason's Resort; 3-day running mean ERC: 48.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 8.3%
Gleason's Resort; 3-day running mean 10 Hr: 14.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: no data
Monture, 24 hr High-Low range, 10 Hr fuel: no data
Benchmark, 24 hr High-Low range, 1 Hr fuel: 28-6%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 30-11%

BEHAVE Fuel Moisture:
(West Zone) No data
(East Zone) 24 hr High-Low range, 1 Hr fuel: 27-8% at 6800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 9-8%

RAWS Fire Weather: Monture 24 hr temperature range: no data
Monture 24 hr relative humidity range: no data
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1400 hrs readings; no data)
Benchmark 24 hr temperature range: 39-74F
Benchmark 24 hr relative humidity range: 27-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-21
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):4-26
(Benchmark 1346 hr readings; 72F, 28%, 6 MPH gusts to 17)
(Benchmark received .02" of rain between 2046-2246 hrs, the first rain at this station since at least July 24th.)

Fire Behavior: Fire was generally inactive with increased humidity and arrival of some light rains. East Zone peak Probability of Ignition during the day at the elevation of the spot fires along the Continental Divide was 40%.

0009 hrs. "Receiving lightning Odgen (Mountain), south side of district." (Silver King Lookout radio log.)

0130 hrs. "Storm moves northeast over divide, 18 strikes. Going to bed." (Silver King Lookout radio log.)

0700 hrs. Wind west 8-14 MPH, 48 degrees, partly cloudy with high clouds to the south, .02" precipitation." (Silver King Lookout radio log.)

1200 hrs. "Buiding cumulus, same pattern as yesterday's." (Silver King Lookout radio log.)

1645 hrs. "No activity Upper Twin Creek; South Fork Bald Bear a little activity; North Fork moderate activity but no flames. Wind erratic / slight blowing upslope; smoke over Lost Cabin Creek." (Transmission from the Welcome Creek Guard Station providing weather observations from ridge top to the Augusta Information Station, radio log.)

1955 hrs. "No thunderstorms." (Silver King Lookout radio log.)

Regional Weather: The upper level trough of low pressure reminded just off the Pacific Northwest coast providing a hot, dry south to southwest air flow over the western portions of the Region and the Northern Rockies. Skies were partly cloudy across the Region during the night with widely scattered, mostly dry thunderstorms. Total lightning strikes for the previous 24 hour period was 1,956 which were concentrated in the northern portions of the Rocky Mountains and east across the hi-line. Low temperatures in the morning ranged from the mid-40's in the northwest portion of the Region to the mid-70's in the southeast. The coolest was Kalispell with 47, and Broadus was the warmest with 73. Weak high pressure brought clear, sunny skies to the Region during the afternoon. Afternoon temperatures were mostly 75 to 85 degrees, with 90's in the southcentral and southeast. Temperatures ranged from 77 at Libby to 90 at Miles City. Winds were still gusting in the Glasgow area between 35 and 40 MPH, but elsewhere had diminished to 10 to 20 MPH with light winds in western Montana. Winds were reported to have died down considerably during the afternoon in Yellowstone National Park (Bushey, 1989).

Long-Range Weather Forecast: Three to five day forecast was for very warm temperatures and dry conditions except for widely scattered afternoon and nighttime thunderstorms. The six to ten day outlook indicated much above normal temperatures with below normal precipitation. Normal high temperatures are usually in the upper 70's and 80's (Bushey, 1989).

AUGUST 17 (Julian Date 230)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 61.0
Seeley Lake Ranger Station; 3-day running mean ERC: 42.0
Gleason's Resort; 3-day running mean ERC: 48.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 8.0%
Gleason's Resort; 3-day running mean 10 Hr: 14.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: no data
Monture, 24 hr High-Low range, 10 Hr fuel: no data
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-7%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 26-10%

BEHAVE Fuel Moisture:

(West Zone) No data
(East Zone) Insufficient data

RAWS Fire Weather: Monture 24 hr temperature range: no data
Monture 24 hr relative humidity range: no data
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1400 hrs readings; no data)
Benchmark 24 hr temperature range: 39-79F
Benchmark 24 hr relative humidity range: 26-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-14
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):3-27
(Benchmark 1346 hr readings; 79F, 26%, 11 MPH gusts to 23)
(figures 70 - 73)

Fire Behavior: Fire remained inactive with only low intensity burning inside the fire perimeter.

0700 hrs. Clear, winds southeast 10-14 MPH. No activity on Canyon Fire, but can smell smoke from Warm Springs." (Silver King Lookout radio log.) [Note; the Warm Springs Fire had a major blowout on the east and north flanks pushed by 40 MPH winds. The fire made a 5 1/2 mile run and was reported to be burning very intensely with structures known to be within the fire perimeter. It was later determined that the fire burned about 12,000 acres on this evening, and an additional 17,000+ acres burned on the 18th. Ten residences were destroyed.]

1748 hrs. "Fire appears to be cold. Smoking North Fork of Baldy Bear drainage. Area of fire not increased significantly today. Winds gusty but not at fire site. Spot Weather: mostly cloudy, DB 71, WB 54, upslope winds 0-4 MPH." (Welcome Creek Guard Station to the Rocky Mountain District, Lewis and Clark National Forest, radio log.) "Most active in Bald Bear; smoking. Winds did not appear to be on the fire. Mostly cloudy skies." (Augusta Information Station radio log.)

Regional Weather: Hot, dry air mass remained over the Region with a light wind flow pattern. Another mostly, dry Pacific weather system was slowly approaching from the west and was expected in the Region by the evening of the 18th or shortly thereafter. Skies were mostly clear across the Region during the night and morning hours with no precipitation reported. An easterly flow continued across the area with winds generally light and less than 10 MPH overnight. Great Falls and Billings occasionally ranged from 15 to 20 MPH. Low morning temperatures were in the mid-30's in the southwest to the high 50's in the southcentral and east. West Yellowstone was the coolest location at 33 degrees, Billings and Miles City the warmest at 59. Slight temperature inversions occurred across the Region during the night and morning. Strong high elevation winds at 0600 hrs were recorded at Boise with 20 to 25 MPH winds at the 5000' - 9000' levels, and at Spokane where 20 - 30 MPH winds occurred between 5000' - 9000' and 35 - 45 MPH speeds above 9000'. During the afternoon the surface high pressure maintained the easterly light wind flow. By noon smoke had reduced visibility to 1/2 mile at West Yellowstone. Afternoon temperatures were in the 80's and low 90's, and ranged from 81 at Grangeville and 83 at Cutbank to 98 at Thompson Falls (Bushey, 1989).

Figure 70. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for August 17 - August 21, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

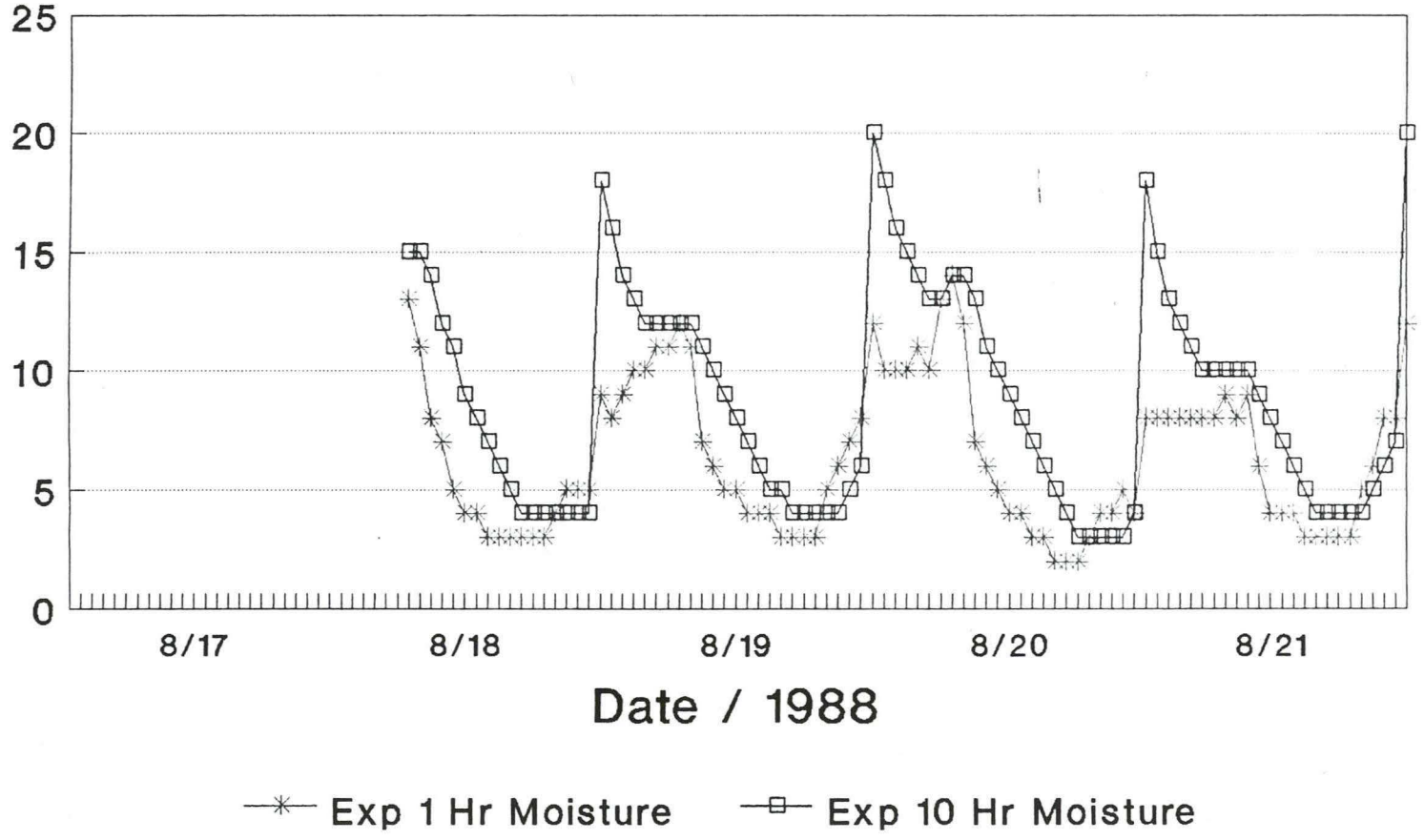


Figure 71. Monture RAWS Station air temperature and relative humidity measurements for August 17 - August 21, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

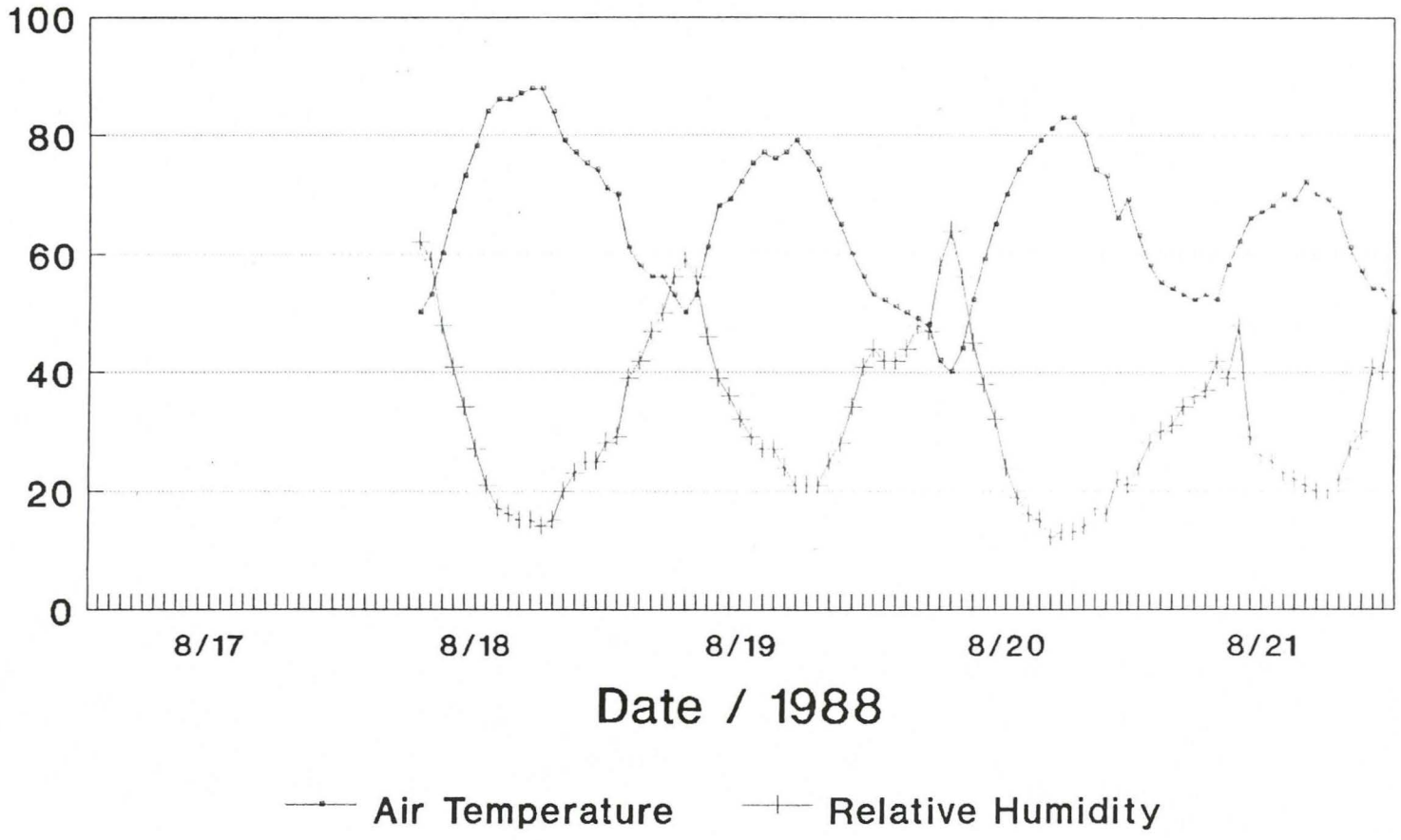


Figure 72. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for August 17 - August 21, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)

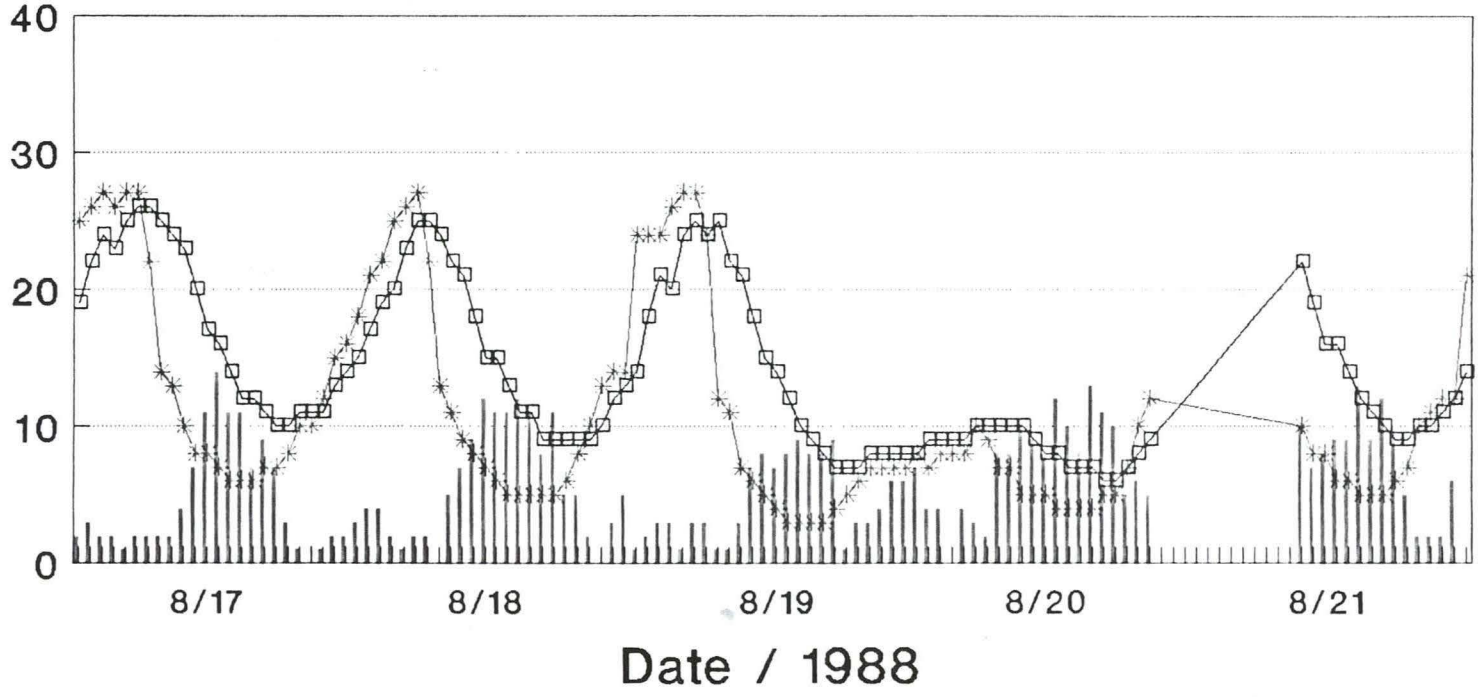
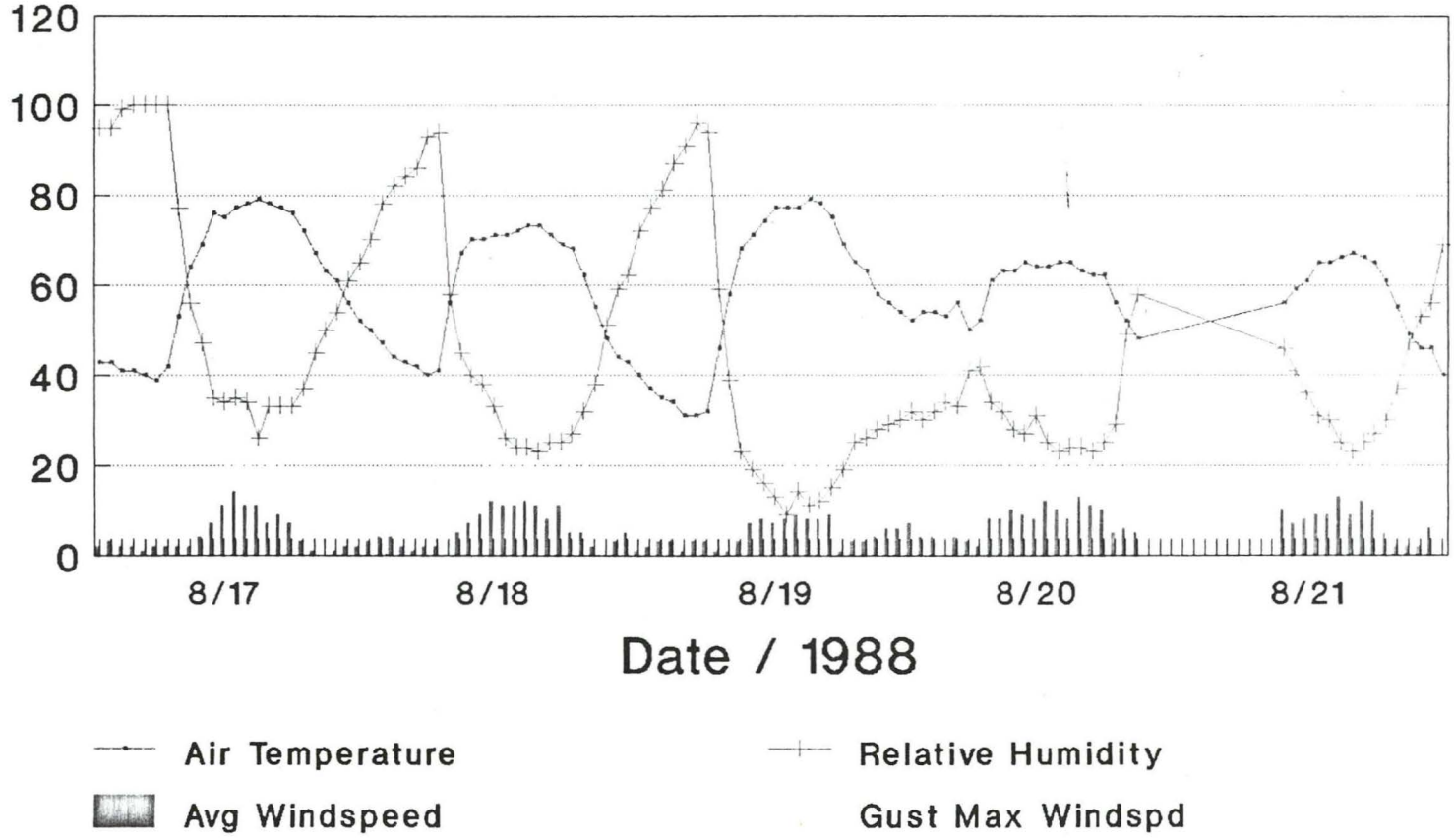


Figure 73. Benchmark RAWS Station air temperature and relative humidity, average wind speed, and maximum gust wind speed measurements for August 17 - August 21, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)



AUGUST 18 (Julian Date 231)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 62.6
Seeley Lake Ranger Station; 3-day running mean ERC: 43.0
Gleason's Resort; 3-day running mean ERC: 50.3

The Lincoln Ranger Station exceeds the ERC 90th percentile (ERC = 62) based on the level established within the Fire Management Plan and would remain above this level for the next eight days.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 6.3%
Gleason's Resort; 3-day running mean 10 Hr: 12.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 13-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 15-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-5%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 25-9%

BEHAVE Fuel Moisture:

(West Zone) 24 hr High-Low range, 1 Hr fuel: 13-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%
24 hr High-Low range, 1 Hr fuel: 13-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

(East Zone) 24 hr High-Low range, 1 Hr fuel: 19-6% at 6800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 7-6%

RAWS Fire Weather: Monture 24 hr temperature range: 50-88F
Monture 24 hr relative humidity range: 14-62%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1400 hrs readings; 84F, 21%)
Benchmark 24 hr temperature range: 40-73F
Benchmark 24 hr relative humidity range: 23-94%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-12
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):4-37
(Benchmark 1346 hr readings; 73F, 24%, 12 MPH gusts to 33)

Fire Behavior: The fire for the tenth day was still relative inactive with low intensity burning occurring within the perimeter during most of the day. At 1548 hrs a small column was reported that was originally thought to be in the Lost Cabin Creek drainage, then later across the divide back in the vicinity of Tobacco Valley. Probability of Ignition during the peak afternoon burning period ranged on the fire from 60 - 70% in the West Zone, and 40 - 50% in the east. No new increases in fire perimeter would be mapped on this date.

1225 hrs. "Canyon Creek Fire not doing anything now." (Welcome Creek Guard Station to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1320 hrs. "Fire reported on Falls Creek, north side of Blowout Mountain behind Diamond Bar-X where east fork and west fork meet." (Augusta Information Station radio log.) [Note; they still couldn't find any smoke on Blowout Mountain.]

1548 hrs. "Increase in fire activity in the last 10 minutes; was white smoke now a blackish smoke indicating heavier fuel. In the Lost Cabin area. It is across the divide but feel it is part of the main fire." (Welcome Creek Guard Station transmission to the Augusta Information Station, radio log.)

1705 hrs. "Still smoking however the smoke color is now white. Feel fire increased 40-50 acres today. (Welcome Creek Guard Station transmission to the Augusta Information Station, radio log.)

1800 hrs. Smoke reported by an aerial observer. (Augusta Information Station radio log.)

1800 hrs. "Canyon Fire sends column south of Scapegoat (Mountain), 313 degrees 14'." (Silver King Lookout radio log.)

1815 hrs. Aerial observer reports steady 18-20 MPH winds aloft. (Augusta Information Station radio log.)

1817 hrs. 331 degrees 35 minutes Flathead side; alot of smoke; not a small fire. Beartop Lookout. (Augusta Information Station radio log.)

1910 hrs. "Column other side of the divide! Smoke light in color; no problem." (Welcome Creek Guard Station transmission to the Augusta Information Station, radio log.)

1910 hrs. "Smoke light in color and light buildup...no column visible." (Welcome Creek Guard Station to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1930 hrs. "Smoke on Canyon lays down." (Silver King Lookout radio log.)

Regional Weather: Skies were mostly clear across the Region during the night except along the Idaho / Montana border where some mostly dry thunderstorms were reported. Most of the lightning during the night was concentrated in this area and on the Idaho Panhandle, Flathead, Kootenai, and Lolo National Forests. A total of 200 strikes were recorded during the 24 hour period (there would be discovered a 50 - 60% ignition rate from these strikes). Winds at Missoula and Glasgow were gusting to 20 to 30 MPH after midnight, with most locations reporting speeds of 15 MPH or less. Just before dawn Glasgow was still reporting winds 25 to 30 MPH. Overnight low temperatures were mostly in the 50's and 60's and ranged from 33 at West Yellowstone to 65 at Miles City. The NWS raised Red Flags in western Montana and northern Idaho during the morning for an expected combination of strong, gusty winds, warm temperatures, and low humidities associated with a frontal passage. Red Flags were also raised in eastern Montana for dry thunderstorms, very low humidities, and hot temperatures. By the late afternoon temperatures had warmed into the 80's to high 90's, ranging from 76 in Grangeville (78 in Cutbank) to 99 at Billings. The frontal system had moved east of the divide and was on a Malta to Lewistown to Big Timber line by 1400 hrs. By 1630 hrs the front was extended from

Billings to Yellowstone National Park. Strong thunderstorms moved across northeastern Montana between 2000 and 2200 hrs with strong associated winds. Glasgow reported 70 MPH thunderstorm wind gusts. Glasgow also reported .25" of rain and Broadus .02" (Bushey, 1989).

Long-Range Weather Forecast: Three to five day outlook was for warm and dry with a chance of some thunderstorm activity. Six to ten day outlook indicated above normal temperatures and below normal precipitation (Bushey, 1989).

AUGUST 19 (Julian Date 232)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 63.6
Seeley Lake Ranger Station; 3-day running mean ERC: 43.6
Gleason's Resort; 3-day running mean ERC: 52.0

The Lincoln Ranger Station again moves above the ERC 97th percentile level as determined by the 1973-1987 seasons. This level will be maintained for the next seven days.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.6%
Gleason's Resort; 3-day running mean 10 Hr: 12.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 12-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 18-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 25-7%

BEHAVE Fuel Moisture:

(West Zone)	24 hr High-Low range, 1 Hr fuel: 11-6% at 5600 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 6%
	24 hr High-Low range, 1 Hr fuel: 13-7% at 7800 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 7%
(East Zone)	24 hr High-Low range, 1 Hr fuel: 19-3% at 5700 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 4-3%
	24 hr High-Low range, 1 Hr fuel: 19-3% at 6800 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 4-3%

RAWS Fire Weather: Monture 24 hr temperature range: 52-79F
Monture 24 hr relative humidity range: 21-59%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1400 hrs readings; 75F, 29%)
Benchmark 24 hr temperature range: 31-79F
Benchmark 24 hr relative humidity range: 9-96%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-9
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):3-24
(Benchmark 1346 hr readings; 77F, 14%, 9 MPH gusts to 24)

Fire Behavior: About 1400 hrs a wind driven crown fire started from one of the spot fires thrown over the divide on August 9th. This fire moved to the northeast and burned along the ridge between Bald Bear Creek and Lost Cabin Creek and then down slope toward the Dearborn River approximately 3 hours later. The fire did not cross the river, but did throw some isolated spots across, it was mostly a slow moving surface fire with only occasional torching at this time. Only a narrow area of crown fire reached the river edge after crossing Lost Cabin Creek near its mouth. In the West Zone of the fire the Probability of Ignition ranged from 40 - 50% during the afternoon burning period due to the high minimum relative humidities. East of the divide the Probability of Ignition was much higher, 70 - 80% with much lower humidities. 673 acres were mapped as being burned on this day bringing the total within fire perimeter acreage to 32,821 acres.

0700 hrs. "Clear, 48 degrees, wind west 5-10 MPH." (Silver King Lookout radio log.)

1402 hrs. "Significant activity in Bald Bear drainage since last report five minutes ago; crowning, moving downslope 50 yards, putting up a good column." Welcome Creek Guard Station. (Augusta Information Station radio log.)

1410 hrs. "Last 15 minutes (fire) has gone from ground fire to crown, 150 yards wide in crown, moving toward Lost Cabin Creek. Spots in crown in Lost Cabin Creek." "Flames on divide, small spot in Lost Cabin Creek." Welcome Creek Guard Station. (Augusta Information Station radio log.)

1410 hrs. "Activity on Canyon, putting up a good column, 326 degrees." (Silver King Lookout radio log.)

1425 hrs. "Significant advance on Canyon Creek Fire." (Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1448 hrs. "Wind southwest 6-8 MPH sometimes gusting to 15." (Transmission from the Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1450 hrs. "Not quite 1 mile from trailhead, no problems." (Transmission from the Welcome Creek Guard Station tp the Augusta Information Station, radio log.)

1457 hrs. "Report new spot 1/4 mile in advance, center of southeast 1/4 T18,R09, Section 14." (Transmission from the Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1526 hrs. "Largest Canyon Fire column drifting northeast onto the prairies near Augusta." (Silver King Lookout radio log.)

1603 hrs. "Fire continuing to advance downhill in northeast direction, has reached the point where Bald Bear Creek jogs to the southeast." (Transmission from the Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1629 hrs. "Fire front now 1/4 mile from river on Bald Bear Creek." (Transmission from the Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1655 hrs. "New start in Mineral Creek, Iron Mountain, T16N, R10W, Section 33, center." (Silver King Lookout radio log.) [Note; this is just within the Scapegoat Wilderness boundary.]

1700 hrs. "DB 63, WB 41, RH 9%, wind west 10-16 MPH." (Silver King Lookout radio log.)

1719 hrs. "Canyon Creek Fire appears to have crossed to northeast side of Dearborn." (Aerial observer to the Augusta Information Station, radio log.)

1720 hrs. "Canyon Creek run, north side of Dearborn River drainage. Going up other side." (Aerial observer to the Rocky Mountain District, Lewis and Clark National Forest, radio log.) [Note; fire on north side of Dearborn were spot fires which did not travel any further.]

1720 hrs. "This report surprises us, visibility not good in area of Lost Cabin Creek. From (our) position can't see." (Transmission from the Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1800 hrs. "DB 64, WB 42, RH 11%." (Silver King Lookout radio log.)

1855 hrs. "Last 30 minutes fire has been on ground, no more crowning runs. Still call it on southwest side of Dearborn River." (Transmission from the Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1910 hrs. "Canyon Fire still all west of Dearborn, intensity decreasing, estimate could hit river in an hour, starting to get shade." (Aerial observer to the Augusta Information Station, radio log.)

1927 hrs. "We found the spot, about ten square feet." (Aerial observer to the Augusta Information Station, radio log.)

2037 hrs. "Fire is within 100 yards of river in several places. Estimate 3-4 pumps could handle it; also possibility of spots from ash dropping east side of river." (Transmission from the Welcome Creek Guard Station to the Augusta Information Station, radio log.)

Regional Weather: During the early morning hours winds returned to 15 MPH or less across the Region after the thunderstorms of the late hours of the previous day. Lighting strikes totaled 4,394 and were confined to areas within the eastern third of Montana and into North Dakota. Skies were clear to partly cloudy except along the North Dakota border through the night. Overnight low temperatures ranged from the high 30's in the southwest to the mid-60's in the east. Drummond had the coolest temperature 35 degrees, Miles City was the warmest at 64. The cool, calm conditions in the western, and central portions of the Region contributed to the creation of morning temperature inversion layers with extensive areas of trapped smoke. Weak high pressure brought sunny afternoon skies with light winds, and drier air. Winds were mostly 5 to 15 MPH, and again visibility was reduced by smoke across the southwestern portion of the Region. Afternoon temperatures were mostly in the 80's, and ranged from 82 at West Yellowstone to 89 at Dillon and Great Falls. Late in the evening a dry cold front moved down from British Columbia creating some thunderstorms along the front with slightly cooler air behind it (Bushey, 1989).

Long-Range Weather Forecast: Three to five day outlook called for slightly cooler temperatures initially, then warming with widely scattered thunderstorms. The six to ten day outlook was for temperatures to be above normal with little or no rainfall. Normal temperatures for this time period are in the 70's to mid-80's range (Bushey, 1989).

AUGUST 20 (Julian Date 233)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 64.0
Seeley Lake Ranger Station; 3-day running mean ERC: 42.3
Gleason's Resort; 3-day running mean ERC: 52.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 6.0%
Gleason's Resort; 3-day running mean 10 Hr: 11.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 14-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 20-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 12-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 10-6%

BEHAVE Fuel Moisture:

(West Zone)	24 hr High-Low range, 1 Hr fuel: 11-4% at 5600 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
	24 hr High-Low range, 1 Hr fuel: 13-4% at 7800 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
(East Zone)	24 hr High-Low range, 1 Hr fuel: 7-5% at 5700 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 6-5%
	24 hr High-Low range, 1 Hr fuel: 8-6% at 6800 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 7-6%

RAWS Fire Weather: Monture 24 hr temperature range: 43-85F
Monture 24 hr relative humidity range: 12-64%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1400 hrs readings; 74F, 19%)
Benchmark 24 hr temperature range: 50-65F
Benchmark 24 hr relative humidity range: 23-58%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-13
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):8-34
(Benchmark 1346 hr readings; 65F, 24%, 8 MPH gusts to 32)

Fire Behavior: Winds during the night from the passing front kept some fire burning through the night within the perimeter interior. During the day the containment effort was remobilized to hold the fire west of the Dearborn River. Five spots on the east side of the Dearborn were found and actively suppressed before afternoon southwest winds arrived. Crews burned out the west line next to the Dearborn (USDA Northern Region, 1989). On the West Zone of the fire the Probability of Ignition during the afternoon was 60% at all elevations and on the East Zone 50%. Wind gusts to 30 MPH east of the divide

during the afternoon caused some control problems, but humidities stayed high helping the containment action. The winds also kicked up some activity at other widely scattered locations but no new fire perimeter growth was recorded for the day.

0700 hrs. "Partly cloudy, smoky. Very windy west 12-20 MPH. Activity on Section 4 ridge all night." (Silver King Lookout radio log.) [Note; Mineral Mountain area.]

0855 hrs. "Canyon smoke, little activity now. Alot last night." (Silver King Lookout radio log.)

0904 hrs. "Fire hotter at this time, all on the ground. has not expanded since last night. Sighted spot across the river." (Transmission from the Welcome Creek Guard Station to the Augusta Information Station, radio log.)

0912 hrs. "Three spots of fire across the Dearborn River, two at same elevation one is right on river..." (Aerial observer to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1200 hrs. "Winds 24-28 MPH, gusting low 30's." (Silver King Lookout radio log.)

1210 hrs. "Activity on Section 4 mountain top to south and east." (Silver King Lookout radio log.)

1235 hrs. "Dropping (water) on spots so far have held them down. Not sure how much longer with the winds. Spots still in the same location." Elk Creek Fire Camp transmission to the Augusta Information Station, radio log.)

1410 hrs. "Moderate activity on fire. Winds west 16-18, gusts to low 20's." (Silver King Lookout radio log.)

1425 hrs. "5 spots across Dearborn." (Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1425 hrs. "5 spots now. . . Winds are at 30 MPH but have (not) shut down operations as of yet, generally west / southwest." (Augusta Information Station radio log.)

1431 hrs. "Winds are more west than southwest and across slope, not across Dearborn, prediction is for north / northwest winds." (G. Curtis, Tactical Team Leader to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1431 hrs. "Have felt fire half a dozen times and it is cold." (Welcome Creek Guard Station to the Rocky Mountain District, Lewis and Clark National Forest, radio log.) [Note; refers to spots across the Dearborn.]

1435 hrs. "DB 50, WB 37." (Silver King Lookout radio log.)

1450 hrs. "Started backing fire...; not burning to intensely. One spot 1/10 acre; need three new bodies to line this one." (G. Curtis, Tactical Team Leader to the Augusta Information Station, radio log.)

Weather Forecast: Pacific cool front will cross the area this morning, rather weak passage. However, upper level disturbance crossing this afternoon for instability and wind, cooler and more stable airmass tonight and Sunday.

Weather for first burn period... today
Weather...partly cloudy. Isolated thunderstorms possible.
CWR...10%
Temperature...maximum 60's
Humidity...min near 15%, likely rising later afternoon.
Wind..eye level..erratic 3 to 12, afternoon wind increasing and becoming northwest gusts to 30 at times on ridges and upper slopes. Likely canyon winds to 30 at times toward late afternoon and evening.
Weather for second burning period...tonight
Weather...few light showers in area
Temperature...good cooling, minimums 40's
Humidity...better recovery, 70 to 80% with 55 to 65 upper slopes and ridges
Wind..eye level..erratic 3 to 10 MPH, northwest 15 to 20 across the ridges
Outlook for Sunday...fair and cool. Min humidities 25 to 35%, max temperatures 55 to 60. Winds northwest 15 to 25 exposed areas afternoons.

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, Head of the Dearborn River drainage, 0945 hrs. Saturday August 20, 1988)

Regional Weather: Skies were mostly clear across the Region during the night except for the line of thunderstorms along the Canadian dry cold front which was temporarily hung up. Only traces of moisture had been reported. Skies remained smokey from the forest fires and winds were generally light at most locations. Glasgow was reporting since midnight 15 to 25 MPH gusts. Low overnight temperatures ranged from 38 at Butte to 63 at Miles City and Broadus. In the morning the NWS issued Red Flag Warnings in northcentral Idaho and westcentral Montana for extremely low humidities and dry lightning in the mountains; and in eastcentral Montana for late afternoon and evening strong thunderstorms, strong winds, and poor humidity recovery. During the afternoon clouds from the weather system centered in southern Alberta were creating widely scattered showers in the northwest quarter of the Region, mostly over Kalispell and Glacier National Park. Hail was reported at Kalispell at noon. Elsewhere skies were partly cloudy. The leading cold front was in central Montana by 1100 hrs and was producing gusty west to northwest winds of 15 to 30 MPH. Front started to affect the Yellowstone area early in the afternoon. Northwest gusts reached 44 MPH at Cutbank and 35 MPH at Great Falls and Livingston, and average from 20 to 30 MPH in Yellowstone National Park with gusts to 40 MPH, higher peaks had 60 to 70 MPH winds. By 1500 hrs the front was on a line from Malta-Lewistown-Big Timber to just northwest of West Yellowstone and was gaining strength and speed. Afternoon temperatures ranged from the upper 50's and low 60's in the northwest to the 90's in the southeast. Broadus was the warmest location at 103 degrees (Bushey, 1989).

Long-Range Weather Forecast: Three to five day forecast called for fair and mild at first, then warming on the 23rd and 24th. Widely scattered showers and thunderstorms in eastern areas. The six to ten day outlook was for above normal temperatures and below normal precipitation. Normal high temperatures are typically in the 70's to mid-80's range at this time of the season (Bushey, 1989).

Miscellaneous: The long term Palmer Drought Severity Index remained essentially unchanged from earlier maps as abnormal dryness continued to cover most of the Region (Bushey, 1989).

AUGUST 21 (Julian Date 234)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 64.5
Seeley Lake Ranger Station; 3-day running mean ERC: 42.3
Gleason's Resort; 3-day running mean ERC: 51.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 6.0%
Gleason's Resort; 3-day running mean 10 Hr: 11.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 9-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 18-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 12-5%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 22-9%

BEHAVE Fuel Moisture:

(West Zone)
24 hr High-Low range, 1 Hr fuel: 8-5% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-6%
24 hr High-Low range, 1 Hr fuel: 10-6% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6%

(East Zone)
24 hr High-Low range, 1 Hr fuel: 11-7% at 5700 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 8-7%
24 hr High-Low range, 1 Hr fuel: 12-8% at 6800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 9-8%

RAWS Fire Weather: Monture 24 hr temperature range: 49-71F
Monture 24 hr relative humidity range: 20-53%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1400 hrs readings; 67F, 23%)
Benchmark 24 hr temperature range: 40-67F
Benchmark 24 hr relative humidity range: 23-69%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-13
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):6-29
(Benchmark 1346 hr readings; 66F, 25%, 13 MPH gusts to 24)

Fire Behavior: Afternoon humidities stayed high and temperatures moderately low on both sides of the Continental Divide keeping fire behavior down to low intensity burning within the interior. Peak afternoon burning period Probabilities of Ignition on the West Zone of the fire were 50% and on the East Zone 30 - 40%. A 10 person crew worked two spots on the Lake Mountain area (USDA Northern Region, 1989). An additional 124 burned acres were mapped bringing the digitized within fire perimeter acreage to 32,945 acres.

0700 hrs. "Clear, 35 degrees, wind northwest 10-18 MPH." (Silver King Lookout radio log.)

1055 hrs. "Started lighting (burnout operation) in Dearborn." (Transmission from Youngquist to the Augusta Information Station, radio log.)

1625 hrs. "Large column, coppery colored smoke plume, Mineral Hill (Mountain) Section 4 mountain." (Silver King Lookout radio log.)

1835 hrs. "Column drift northeast / east of Silver King. Drift near Augusta, Dearborn areas. Estimated 40-60 acres burned." (Silver King Lookout radio log.)

Weather Forecast: High pressure building into area next 2 days with warming and drying. Pressure gradient lessening for diminishing winds.

Weather for first burn period... today
Weather...few cumulus clouds
CWR...zero
Temperature...from 65 bottoms to 58 top
Humidity...20 to 30%
Wind..eye level..mostly afternoon upslope 0 to 8, northwest to west 15 little gusty upper slopes/ridges
Weather for second burning period...tonight
Weather...mostly clear
CWR...zero
Temperature...near 30 with 25 high elevations
Humidity...80 to 90% bottoms, 50 to 60% slopes and ridges
Wind..eye level..downslope 0 to 5, northwest to northeast 5 to 15 ridges
Outlook for Monday...Little warmer and drier, with northeast to southeast winds 6 to 12.

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, Head of the Dearborn River drainage, 0930 hrs. Sunday August 21, 1988)

Regional Weather: Skies overnight across the Region during the morning hours were fair to partly cloudy except for a northeast-southwest line of showers through central Montana. Only isolated lightning had occurred during the previous 24 hours with a total of 433 strikes most of which were on the Idaho Panhandle, Kootenai, and Flathead National Forests during yesterday afternoon. A narrow band of strikes occurred south of the Yellowstone area and across eastern Montana and into North Dakota as the front passed through that area. Winds were mostly light and less than 15 MPH. Overnight temperatures were in the 40's and 50's, and ranged from 35 at Drummond to 59 at Broadus. By late afternoon western portions of the Region were clear as a high pressure ridge moved into the Region from the Pacific, and east of the continental divide skies were partly cloudy in the north and sunny in the south. A Red Flag was issued in the afternoon for strong winds along the Canadian border in eastern Montana associated with an upper level disturbance. Northeast Montana reported the strongest winds with Glasgow reporting gusts from 30 to 40 MPH. Afternoon temperatures were in the upper 70's and 80's, ranging from 72 at West Yellowstone to 83 at Thompson Falls (Bushey, 1989).

AUGUST 22 (Julian Date 235)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 65.5
Seeley Lake Ranger Station; 3-day running mean ERC: 42.6
Gleason's Resort; 3-day running mean ERC: 52.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.6%
Gleason's Resort; 3-day running mean 10 Hr: 10.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.5%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 20-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 20-5%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 25-8%

BEHAVE Fuel Moisture:
(West Zone) 24 hr High-Low range, 1 Hr fuel: 18-6% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6%
24 hr High-Low range, 1 Hr fuel: 20-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
(East Zone) 24 hr High-Low range, 1 Hr fuel: 17-5% at 5700 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6-5%
24 hr High-Low range, 1 Hr fuel: 20-5% at 6800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6-5%

RAWS Fire Weather: Monture 24 hr temperature range: 35-72F
Monture 24 hr relative humidity range: 20-77%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1400 hrs readings; 65F, 31%)
Benchmark 24 hr temperature range: 34-78F
Benchmark 24 hr relative humidity range: 14-95%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-10
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):3-23
(Benchmark 1346 hr readings; 75F, 16%, 10 MPH gusts to 21)
(figures 74 - 77)

Fire Behavior: About 1400 hrs the fire east of the divide started to burn more actively as afternoon temperatures moved above 75F and humidities dropped below 20% and winds started to increase. A small area near the mouth of Bald Bear Creek started some torching and spotting behavior. The fire spotted east of the Dearborn River but the team put a line around it and it held. Burnout operations continued, and were completed on the west side of the Dearborn. Five spots on the east side of the Dearborn were cool, and George Curtis didn't see the need to burnout the wilderness boundary. New spots were found on the south side of Bald Bear Creek and the north side on Lost Cabin Creek. The crew working on Lake Mountain was told to report to Augusta following suppression of the last smoke observed from air at approximately 1600 hrs to help with spot fires on the east side of the divide. Probability of Ignition on the West Zone of the fire rose to 50% during the afternoon, while the East Zone ranged from

Figure 74. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for August 22 - August 26, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

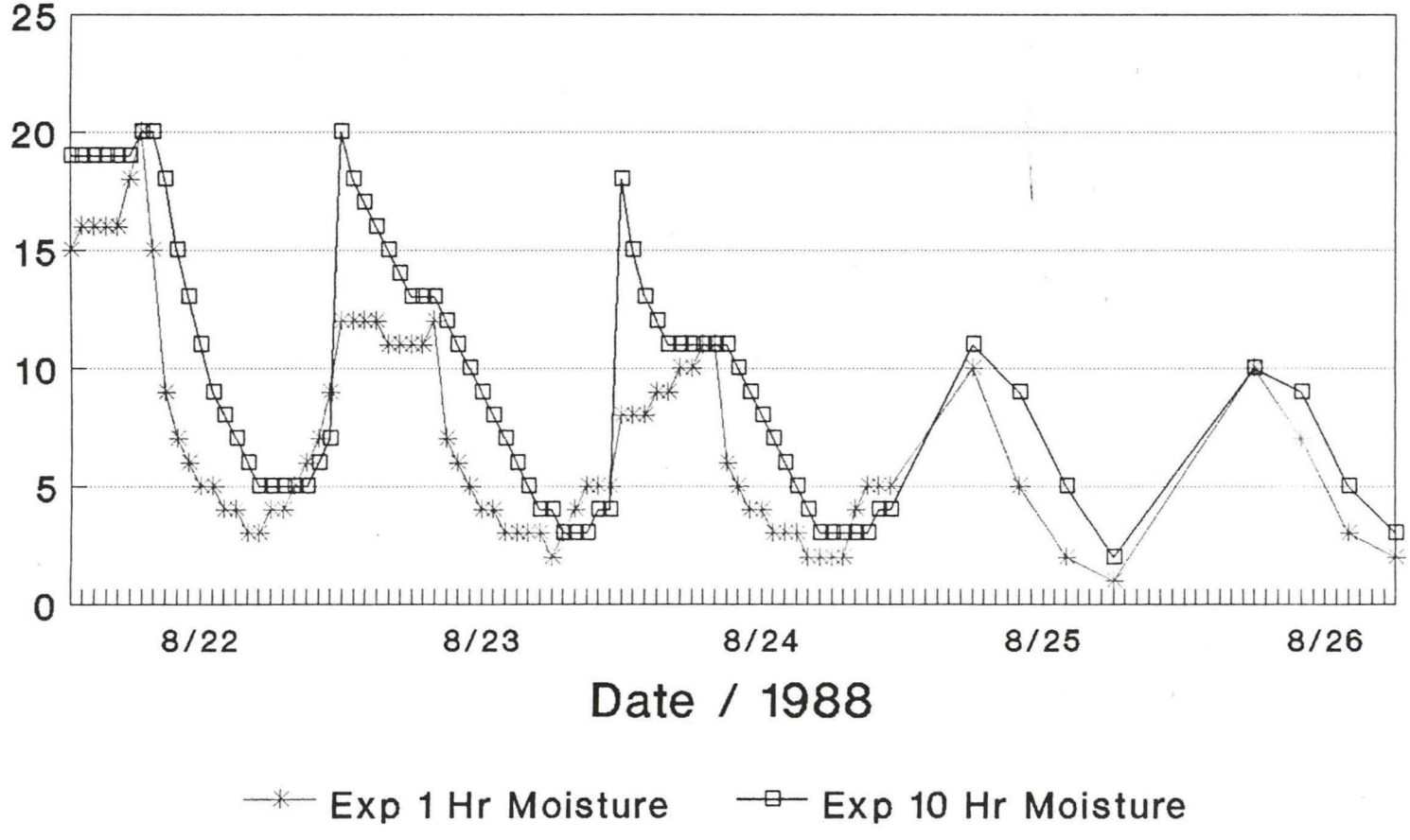


Figure 75. Monture RAWS Station air temperature and relative humidity, measurements for August 22 - August 26, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

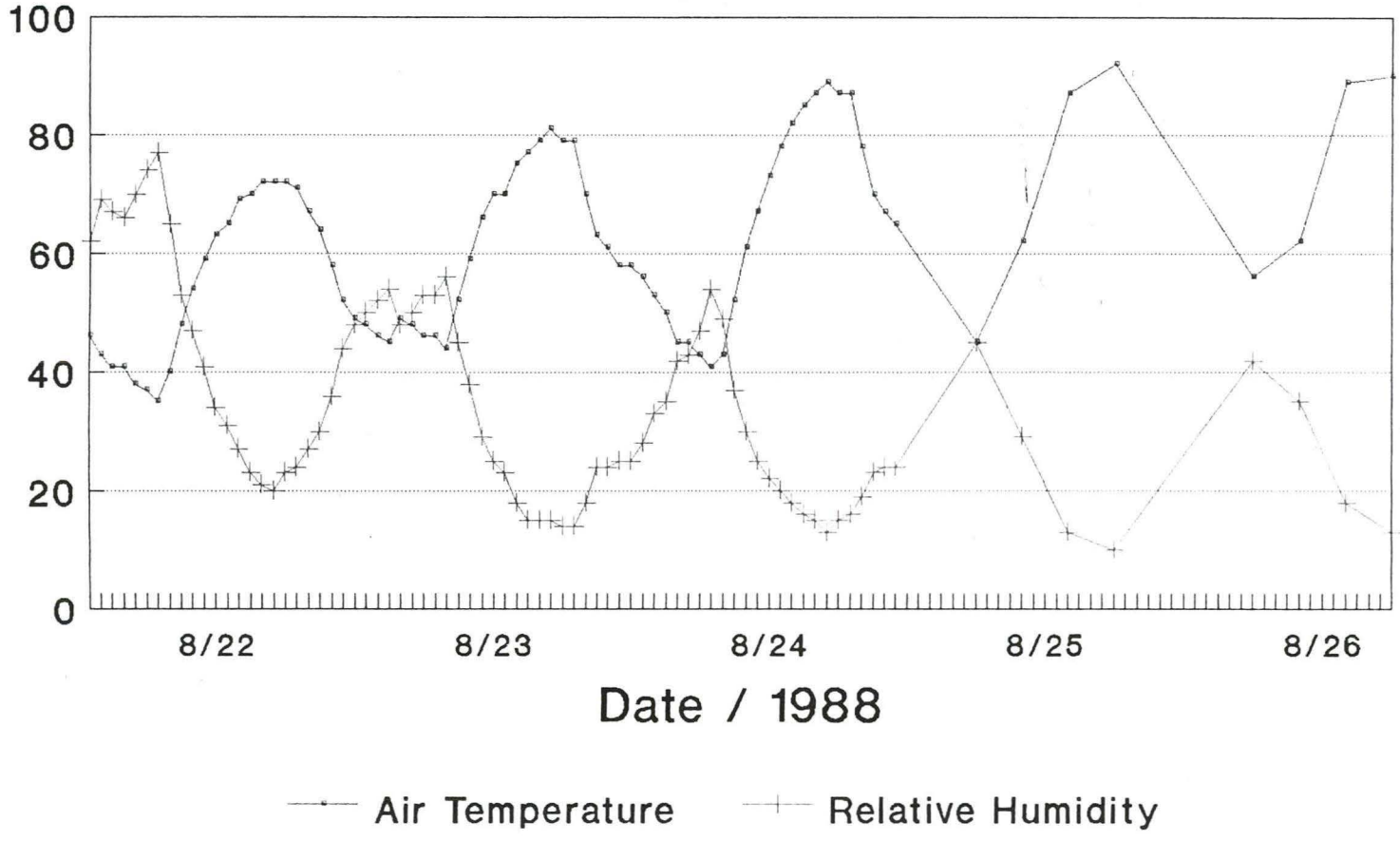


Figure 76. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and precipitation measurements for August 22 - August 26, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)

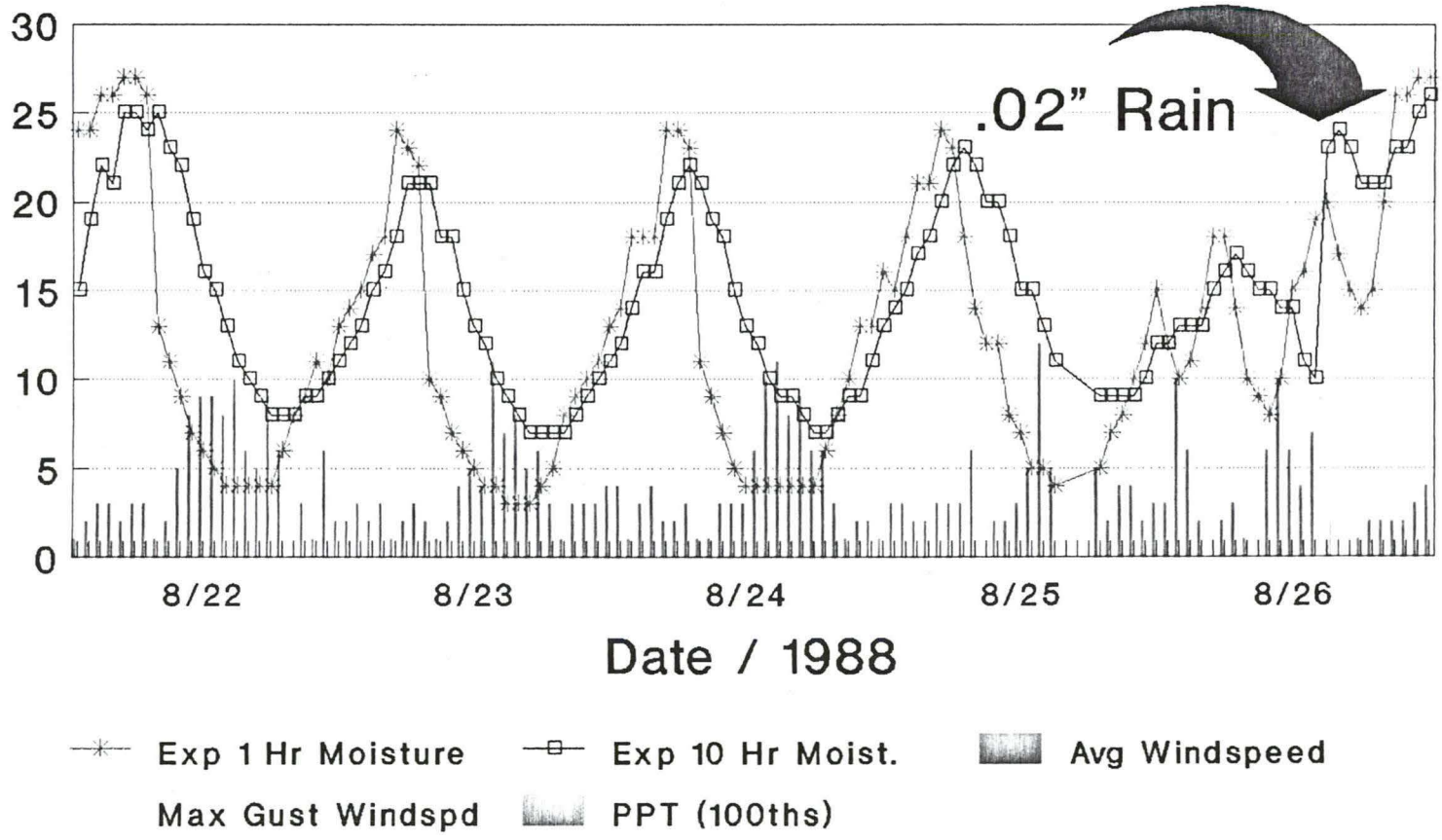
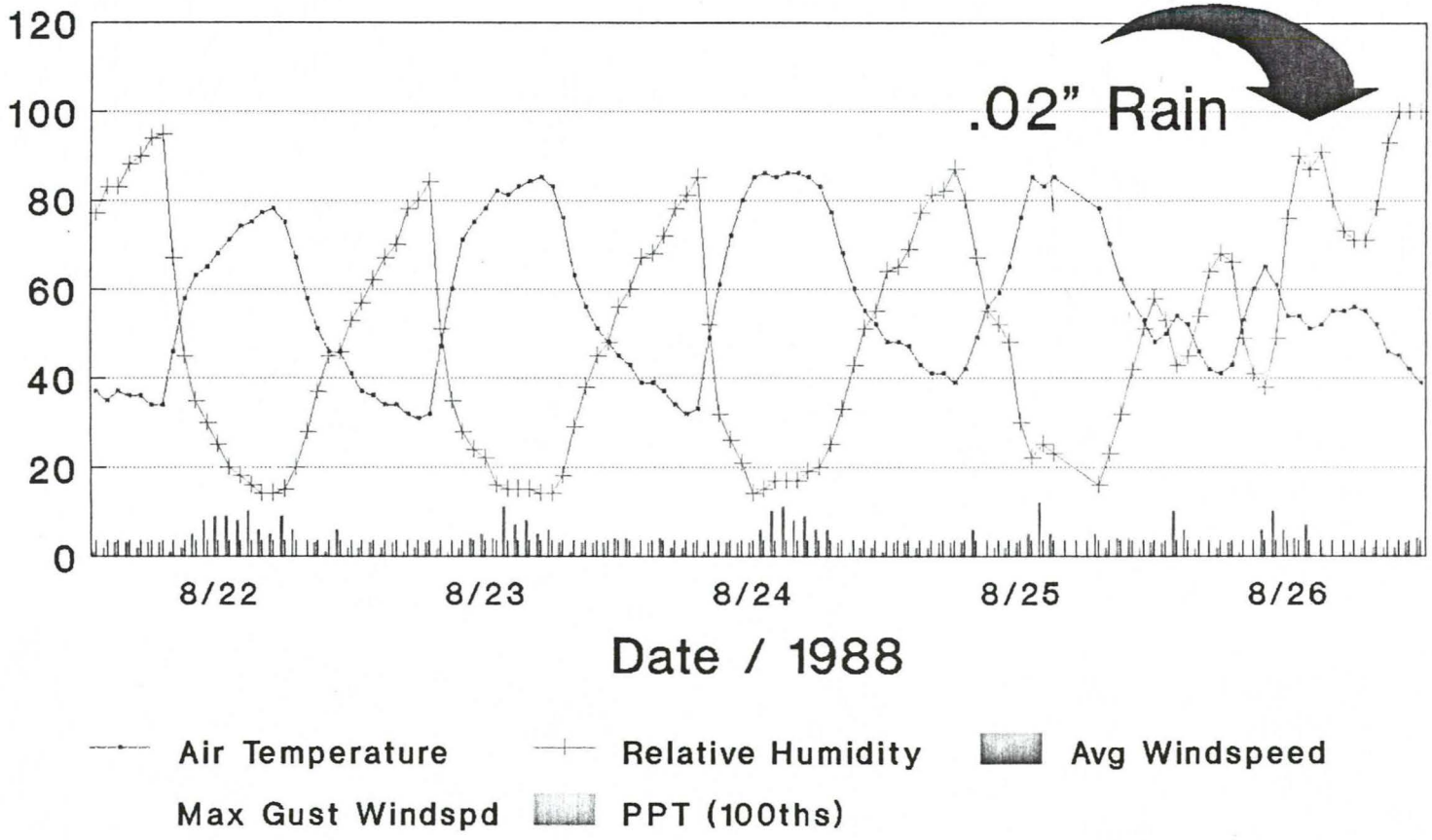


Figure 77. Benchmark RAWS Station air temperature and relative humidity, average wind speed, maximum gust wind speed, and precipitation measurements for August 22 - August 26, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)



50 - 60%. The fire was estimated at 33,500 acres at the time (USDA Northern Region, 1989).

0700 hrs. "Clear, calm, no wind." (Silver King Lookout radio log.)

1405 hrs. "Canyon smoking up some." (Silver King Lookout radio log.)

1440 hrs. "Bald Bear (Creek) is really rolling, keep an eye on it!" (Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1445 hrs. "East side of Dearborn, smoke down canyon." (Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1515 hrs. "Large spot south of Cabin Creek." (Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1715 hrs. "Canyon smokes large Whitetail Creek east of divide, north of Dearborn River; another McDonald Meadows-Tobacco Valley area. Numerous other smaller [columns] all forming blanket smoke drifting east into valleys north of Silver King. Wind west / northwest 16-18 MPH." (Silver King Lookout radio log.)

1758 hrs. "Burnout (operation) doing well...a few spots over Dearborn, have people on it." Eiseman. (Augusta Information Station radio log.)

1804 hrs. "Can see flames on ridge from Canyon Creek." (Aerial observer to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1810 hrs. "Everything is going well, one spot over the Dearborn." Elk Creek Camp. (Augusta Information Station radio log.)

1845 hrs. "Large dark column smoke Canyon Fire, Whitetail Creek, Carmichael Basin, Dearborn River. Temperature 64 degrees, wind west 16-20 MPH." (Silver King Lookout radio log.)

Weather Forecast: Northerly flow aloft late today as upper air ridge moves slowly in from the Pacific. Upper air ridge should be over the area Tuesday and Wednesday for light winds and warming temperatures. Humidity recovery becoming poor at night due to very dry air in the upper air ridge. No strong winds indicated in our weather charts Tuesday and Wednesday.

Weather for...Tonight
Weather...clear
CWR...none
Temperature...valleys 40 ridges 42
Humidity...min valleys 57% ridges 52%
Wind..eye level..down slope 4 to 9 MPH ridge north 18 MPH
Weather for...Tuesday
Weather...clear
CWR...none
Temperature...max valleys 75 ridges 70
Humidity...min valleys 17% ridges 20%
Wind..eye level..light easterly 3 to 8 MPH
Outlook for Wednesday...clear dry weather with poor humidity recovery at night. A few degrees warmer. Winds mostly slope winds 3 to 8 MPH.

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, Head of the Dearborn River drainage, 1620 hrs. Monday August 22, 1988)

Regional Weather: Building high pressure was expected to continue for another 2-3 days with warming temperatures and very low humidities. Skies were clear through the night, winds died down and were less than 15 MPH. The northern lights were visible at several stations during the very early morning hours. Overnight temperatures were in the 40's and 50's, ranging from 25 at West Yellowstone to 54 at Miles City. Temperatures cooled into the 30's at most locations over 5,000' and humidity recovery was much improved except for southwestern Montana and the east slopes of the Rockies were it remained dry. Lightning activity during the past 24 hours was restricted to 148 strikes in northcentral Wyoming. High pressure at the surface and aloft were building. High clouds covered the northeast portion of the Region during the afternoon while everyone else enjoyed sunny skies. West to northwest winds were gusting to 25 MPH in many areas. Afternoon temperatures were in the 70's and 80's, ranging from 75 at Lewistown to 89 at Thompson Falls. In Yellowstone National Park, Tower Falls recorded an afternoon low relative humidity of 6% which would be the lowest humidity reading in the Park during the year (Bushey, 1989).

Miscellaneous: A subsidence inversion dropping below 9000 ft was noted by the RICO Fire Behavior Service Center (Bushey, 1989).

AUGUST 23 (Julian Date 236)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 66.3
Seeley Lake Ranger Station; 3-day running mean ERC: 44.3
Gleason's Resort; 3-day running mean ERC: 54.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.6%
Gleason's Resort; 3-day running mean 10 Hr: 9.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.3%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 12-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 20-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 24-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 21-7%

BEHAVE Fuel Moisture:

(West Zone)	24 hr High-Low range, 1 Hr fuel: 10-4% at 5600 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
	24 hr High-Low range, 1 Hr fuel: 12-5% at 7800 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
(East Zone)	24 hr High-Low range, 1 Hr fuel: 14-4% at 5700 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
	24 hr High-Low range, 1 Hr fuel: 15-4% at 6800 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%

RAWS Fire Weather: Monture 24 hr temperature range: 45-81F
Monture 24 hr relative humidity range: 14-56%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1400 hrs readings; 74F, 23%)
Benchmark 24 hr temperature range: 31-85F
Benchmark 24 hr relative humidity range: 14-84%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-11
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):3-21
(Benchmark 1346 hr readings; 83F, 15%, 7 MPH gusts to 17)

Fire Behavior: Fire was active in many locations but only increased perimeter size in one area, on the northeast facing slope above Bald Bear Creek and the Dearborn River. Upper elevations of the fire on the West Zone experienced Probability of Ignition fo 50 - 60%, while lower elevations had risen to 60% with the lowering of relative humidities from the previous day. The East Zone attained Probability of Ignition of 70%.

0700 hrs. "Clear, calm, 54 degrees." (Silver King Lookout radio log.)

0830 hrs. "Everything holding except the spot at Bald Bear (Creek)." (Augusta Information Station radio log.)

0837 hrs. "Over Dearborn headed for Choteau, lots of smoke, all activity is confined to west side of Dearborn." (Aerial observer to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1115 hrs. "Fire on Mineral same location S/SE side Section 4 mountain ridge." (Silver King Lookout radio log.)

1440 hrs. During the flight over the Continental Divide, Curtis observed spot fires on the Lolo National Forest west of Cave Creek (head of Dobrota Creek) and in Lost Cabin Creek on the Lewis and Clark National Forest National Forest (USDA Northern Region, 1989). Spots were caused by the intense crowning and burning north of the Dobrota Creek drainage on the Lolo side of the Continental Divide which had occurred back on July 26th and which were again active. Remapping of the fire showed it at 34,000 acres (USDA Northern Region, 1989).

1505 hrs. "Fire spotted across, Section 13, T18N, R09W, west of Steamboat Mountain." (G. Curtis Tactical Team Leader to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1540 hrs. "Status of fire: close to Lost Cabin Creek drainage across the Dearborn." (Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1555 hrs. Curtis requested assistance on the spot fires along the ridge on the Continental Divide near the head of Cave Creek and Lost Cabin Creek.

1600 hrs. "Large blanket smoke, no column drift." (Silver King Lookout radio log.)

1640 hrs. "Gary cancelled retardant 1 hr ago, spot east of Dearborn is contained." (Rocky Mountain District, Lewis and Clark National Forest, radio log.)

Weather Forecast: Hot dry high pressure will continue over area next few days. Light wind pattern. Low humidity recovery some slopes/ridges at night.

Weather for first burn period... this afternoon
Weather...sunny
CWR...zero
Temperature...80s
Humidity...15 to 25%
Wind..eye level..mostly light terrain winds, southeast to east 15 ridges
Weather for second burning period...tonight
Weather...mostly clear
Temperature...40 to 50 with 30s high elevations
Humidity...recovery to near 80% bottoms, 35% ridges/slopes
Wind..eye level..light downslope, southeast 10 MPH ridges
Outlook for Wednesday...little change

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, Head of the Dearborn River drainage, 0925 hrs. Tuesday August 23, 1988)

Regional Weather: Strong upper ridge of high pressure over the western states continued to hold the storm track to the north over Canada. Skies were clear during the night across the Region, winds were light and less than 15 MPH. The subsidence inversion contributing to drying fuel conditions at the higher elevations dropped to between 5,000 - 6,000 ft in elevation during the night. Later that morning the inversion rose to the 8,000 ft level. High pressure was rebuilding. Overnight temperatures were in the 40's and 50's, ranging from 26 degrees at West Yellowstone to 55 at Miles City. Afternoon winds across the Region were generally light except for the northwest corner where breezes of 10 to 20 MPH were reported. The light winds failed to blow out the smoke from the fires burning in Yellowstone National Park and visibility was reduced to less than a mile at West Yellowstone. Afternoon temperatures reached into the 80's and 90's, ranging from 79 at Libby to 100 degrees at Thompson Falls (Bushey, 1989).

Long-Range Weather Forecast: Three to five day forecast was for hot and dry with isolated thunderstorms in the southern zones near the mountains and slight cooling to the north. The six to ten day outlook indicated above normal temperatures and below normal precipitation. Normal temperatures are in the 70's to mid-80's range (Bushey, 1989).

AUGUST 24 (Julian Date 237)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 67.0
Seeley Lake Ranger Station; 3-day running mean ERC: 45.0
Gleason's Resort; 3-day running mean ERC: 56.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.0%
Gleason's Resort; 3-day running mean 10 Hr: 8.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 11-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 18-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 24-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 22-7%

BEHAVE Fuel Moisture:

(West Zone) 24 hr High-Low range, 1 Hr fuel: 10-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
24 hr High-Low range, 1 Hr fuel: 12-4% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

(East Zone) 24 hr High-Low range, 1 Hr fuel: 13-5% at 5700 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
24 hr High-Low range, 1 Hr fuel: 15-5% at 6800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

RAWS Fire Weather: Monture 24 hr temperature range: 41-89F
Monture 24 hr relative humidity range: 13-54%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1400 hrs readings; 78F, 20%)
Benchmark 24 hr temperature range: 32-86F
Benchmark 24 hr relative humidity range: 14-85%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-11
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):3-22
(Benchmark 1346 hr readings; 86F, 17%, 11 MPH gusts to 19)

Fire Behavior: Williams observed active fire on the northwest side of Lake Mountain (USDA Northern Region, 1989). This fire seen on the northwest side of Lake Mountain was from the spots which had been tossed over the ridge on August 5th. These spots had continued to smolder and occasionally torch small groups of ABLA/PIEN, which in turn created more embers and spot fires and slowly expanded the extent of burning within this area (Sisk interview). Elsewhere on Canyon Creek activity was low and the perimeter remained at 34,000 acres (USDA Northern Region, 1989). Both East and West Zones had peak afternoon burning conditions with a Probability of Ignition of 60%. During the evening the fires came under the influence of an east wind. Digitized mapping would show 533 acres burned on this day, expanding the within fire perimeter acreage to 33,478 acres.

0700 hrs. "Clear, calm, 55 degrees." (Silver King Lookout radio log.)

0830 hrs. "Canyon Fire is burning to the south of the unnamed peak. Runs are up slopes to the southwest. It's below Lake Mountain on the northwest facing bowel, below the repeater site." (Lolo National Forest Fire Dispatch radio log.)

1330 hrs. No suppression effort was observed on spots on the Continental Divide. Spots torched and spread during the afternoon, burning down the ridge to the south of Bald Bear Creek toward the Dearborn River, then hooking down the Dearborn to the south, then upslope into the next adjacent drainage still on the west side of the river (USDA Northern Region, 1989).

1405 hrs. "Activity around Mineral hill (Mountain), moderate column. Light gray colored. Drift straight up and to the northeast, wind calm to 5 MPH." (Silver King Lookout radio log.)

1900 hrs. Crews continued to burnout on the west side of the Dearborn (USDA Northern Region, 1989).

2030 hrs. Curtis observed that a spot on the east side of the Dearborn had grown to 10 acres (USDA Northern Region, 1989).

Miscellaneous: The Iron Claim fire started on the Lewis and Clark National Forest. By nightfall it was 1000 acres. A lightning storm crossed the Lolo National Forest during the evening (USDA Northern Region, 1989).

Weather Forecast: Strong high pressure ridge over the area for warm dry conditions with light and variable winds.

Weather for...Today
Weather...clear
CWR...none
Temperature...Max valleys 79 ridges 71
Humidity...min valleys 19% ridges 24%
Wind..eye level..light and variable 3 to 8 MPH
Weather for...Tonight
Weather...clear
CWR...none
Temperature...lows tonight 50 to 55
Humidity...recovery tonight 40%
Wind..eye level..light and variable 3 to 8 MPH
Outlook for Friday...little change

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, Head of the Dearborn River drainage, 1035 hrs. Wednesday August 24, 1988)

Regional Weather: As the strong high pressure continued skies were again clear during the night across the Region. Winds were variable and less than 15 MPH. Temperatures last night fell into the 40's and 50's, ranging from 31 at West Yellowstone to 56 at Miles City. The subsidence inversion over the Northern Rocky Mountains lifted during the night to the 14,000 ft level, then dropped to between 10,000 - 12,000 ft level later that morning. During the morning a Red Flag Warning was issued for eastern Montana for very low afternoon and evening humidities below 15%. Clear skies continued to dominate the Region during the afternoon, except where heavy smoke reduced visibilities to less than 1/2 mile in the southwestern portion of the Region. Winds remained variable at 10 MPH or less. Temperatures warmed into the 80's and 90's, ranging from 88 at West Yellowstone to 105 at Thompson Falls. Most stations were in the mid to high 90's. To date, Missoula had received only .29" of rainfall during the month of August, normal for the month was .95". In the last 40 days this station had reported only 3 days with moisture (Bushey, 1989).

Long Range Weather Forecast: Three to five day outlook was for dry and warm with scattered late afternoon and evening thunderstorms. The six to ten day outlook predicted above normal temperatures and below normal precipitation. Normal high tmperatures for this time period are usually in the 70's to low 80's range (Bushey, 1989).

AUGUST 25 (Julian Date 238)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 64.0
Seeley Lake Ranger Station; 3-day running mean ERC: 44.6
Gleason's Resort; 3-day running mean ERC: 49.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.3%
Gleason's Resort; 3-day running mean 10 Hr: 13.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-1%
Monture, 24 hr High-Low range, 10 Hr fuel: 11-2%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 22-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 24-9%

BEHAVE Fuel Moisture:

(West Zone) 24 hr High-Low range, 1 Hr fuel: 10-3% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 3%
24 hr High-Low range, 1 Hr fuel: 12-4% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%

(East Zone) 24 hr High-Low range, 1 Hr fuel: 15-6% at 5700 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
24 hr High-Low range, 1 Hr fuel: 17-6% at 6800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6%

RAWS Fire Weather: Monture 24 hr temperature range: 45-92F
Monture 24 hr relative humidity range: 10-45%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1500 hrs readings; 87F, 13%)
Benchmark 24 hr temperature range: 39-85F
Benchmark 24 hr relative humidity range: 16-87%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-12
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):5-21
(Benchmark 1346 hr readings; 85F, 23%, 5 MPH gusts to 21)

Fire Behavior: Roose estimated that the fire had grown to 100 acres on the northeast of Lake Mountain. One spot was observed high on the south slope of Lake Mountain (USDA Northern Region, 1989). This fire was active with torching trees in the East Fork of Lake Creek by 0800 hrs. The fire would become very active and moving by 1000-1100 hrs. By 1400 hrs the fire would be to intense to be close enough for suppression actions. Additional fire spread was noted on Lake Mountain as the fire backed toward the Madison Creek drainage on the south flank of the mountain. Upslope winds pushed an area of fire up South Creek in a region which had experienced only limited burning since July 31st. The fire would back into the wind until lined up with the wind then make short upslope runs (Roose interview).

North of the Canyon Creek Fire's origin upslope runs were experienced on both sides of the Dry Fork of the North Fork of the Blackfoot River. This area had not experienced any significant fire behavior since the end of July.

Fire was backing down the south and east aspects of Mineral Hill toward Mineral Creek.

Two side drainages, north of the North Fork of the Blackfoot River and east of Dobrota Creek, and a side drainage to Dobrota Creek burned to the Continental Divide on the southeast flank of Scapegoat Mountain. These areas started burned from creeping surface fire and spotting which had occurred on August 9th when Tobacco Valley burned out. Mosaic patterns of crown fire, crown scorch, and unburned forest were created as upslope winds carried the fires toward the Continental Divide located on the southeast flank of Scapegoat Mountain. Firebrands were also carried over into Cave Creek and 2 or 3 spots into Lost Cabin Creek. On the West Zone the Probability of Ignition increased to 80% at the lower elevations and 70% near the mountain timberline.

Mop-up was done on the 10 acre spot east of the Dearborn. Higher relative humidities on this side of the Continental Divide kept the fire behavior low with a peak afternoon burning period Probability of Ignition of 50%. The fire was estimated at the time to be about 35,000 acres (USDA Northern Region, 1989). Burning on this date covered another 3,692 acres bringing the digitized within fire perimeter acreage to 37,160 acres. The fires continued under the influence of an easterly wind.

0710 hrs. "Lady living in Cooper's Lake wondering what Canyon is doing; looks like it's burning pretty good." (Lolo National Forest Fire Dispatch radio log.)

0830 hrs. "Area around Mineral Peak burning very active this morning." (Lolo National Forest Fire Dispatch radio log.)

1200 hrs. "Visibility poor to the south / southwest/west / northwest, winds calm." (Silver King Lookout radio log.)

1400 hrs. "Visibility is poor all around." (Silver King Lookout radio log.)

Weather Forecast: A weak weather system is passing through today. It will move east this afternoon, but will cause some convection activity in the area.

Weather for...this afternoon
Weather...partly cloudy. 10% chance of dry thunderstorms.
CWR...near zero
Temperature...cooler than Wednesday...max 80-85
Humidity...still low...min 15-20%
Wind..eye level..becoming west, 5-10 MPH, especially upper elevation.
Weather for...Tonight
Weather...clearing. 10% chance of early evening thunderstorms.
CWR...near zero
Temperature...min 39-43...watch for thermal belt regions however
Humidity...recovery generally poor...max 55% bottoms, near 35% ridges and midslopes
Wind..eye level..west exposed areas 5-10 MPH, otherwise downslope
Outlook for Friday...Mostly sunny. slight chance of afternoon and evening thunderstorms. Breezy at times from the west 10-15 MPH. Temperatures down about 4 degrees, RH up about 3%.

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, Head of the Dearborn River drainage, 1120 hrs. Thursday August 25, 1988)

Regional Weather: Skies remained clear during the night, winds at most stations were less than 15 MPH. Billings and Miles City were the exceptions, reporting winds from the north and northeast at 10 to 20 MPH. Low temperatures in the morning were mostly in the 50's, ranging from 36 at West Yellowstone to 58 at Billings and Miles City. NWS issued a Red Flag Warning for all of northern Idaho and western Montana for dry lightning, dry fuels, and low humidities. During the morning a small disturbance did sneak in under the dome of high pressure and produced mostly dry lightning from about Missoula northward. A few light showers, mostly just sprinkles, were scattered in areas west of the continental divide. This activity moved east during the afternoon. The largest cell crossed across the Nez Perce and Clearwater National Forests, then crossed the Bitterroot Valley south of Missoula. Considerable lightning and strong gusty winds occurred with this thunderstorm. The cell stalled over the Bitterroot and Deerlodge National Forests and later dispersed during the late morning. At 0600 hrs the subsidence inversion that had been over the Region for several days was approximately at the 12,000 - 13,000 ft elevation between Spokane and Great Falls and had little effect on the fires. By evening partly cloudy skies were across the Region. Eleven out of 18 reporting station from across Montana were reporting smokey skies, Hamilton had 6/10's of the sky covered by smoke and was about the worst. High temperatures ranged from 82 at Glasgow and Miles City to 97 at Thompson Falls (Bushey, 1989).

Long Range Weather Forecast: Three to five day forecast was for near normal temperatures in northern Idaho and western Montana and for above normal temperatures east of the divide. Precipitation was expected to be near normal west of the divide and dry to the east. Normal high temperatures for this time period are inthe 70's to low 80's (Bushey, 1989).

AUGUST 26 (Julian Date 239)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 60.6
Seeley Lake Ranger Station; 3-day running mean ERC: 44.0
Gleason's Resort; 3-day running mean ERC: 45.6

The ERC level at the Lincoln Ranger Station drops below the 97th percentile level as established from the 1973-1987 seasons (ERC = 63), and below the 90th percentile based on the Fire Management Plan (ERC = 62).

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.0%
Gleason's Resort; 3-day running mean 10 Hr: 15.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.3%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 10-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-8%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 26-10%

BEHAVE Fuel Moisture:

(West Zone) 24 hr High-Low range, 1 Hr fuel: 10-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 10-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

(East Zone) 24 hr High-Low range, 1 Hr fuel: 21-13% at 5700 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 21-19 %
24 hr High-Low range, 1 Hr fuel: 24-14% at 6800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 22-24%

RAWS Fire Weather: Monture 24 hr temperature range: 56-90F
Monture 24 hr relative humidity range: 13-42%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1500 hrs readings; 89F, 18%)
Benchmark 24 hr temperature range: 41-56F
Benchmark 24 hr relative humidity range: 68-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-10
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):3-22
(Benchmark 1346 hr readings; 52F, 91%, 0 MPH gusts to 12)
(Benchmark received .02" of rain between 1146-1446 hrs, the last rain was on 8/16 ten days earlier.)

Fire Behavior: The fire south of Lake Mountain continued to act up. The fire backed about 1/4 the distance to Madison Creek. All fire activity in the vicinity was north of Lake Creek and west of Lake Mountain trail. The fire was backing with an average flame length of approximately 3 ft with torching of ABLA as they were encountered, pockets of heavier fuel burned intensily. Area of fuel discontinuity caused the backing fire to create a mosaic of unburned fuel much of which would still remained unburnt on September 6th. The creeping, persistent nature of the fire spread caused some of these areas behind the main backing fire to eventually burn, as did spot fires started from firebrands created by torching trees (Sisk interview). It was thought the fire could be held midslope on Lake Mountain and kept from moving outside the boundary or into the North Fork of the Blackfoot Canyon. Priority was in keeping the fire from spotting on the east side of the North Fork so it would not threaten the Cooper's Lake area.

Even though fire was on the east side of Mineral Peak, it was not considered a threat because it had been there for more than a month with little activity and the area had broken, discontinuous fuels above it and to the south. West Zone Probability of Ignition was the same as the previous day ranging from 60 - 70% at the higher elevations, and 70% near the river valley elevations.

Recon of the Dearborn area showed good progress on mop-up of all lines burned out and no smokes in spot fires east of the river. Action was started on a 6 acre spot fire near the head of Lost Cabin Creek because it was moving downhill with torching and crowning in heavy dead and down fuel. 1/4" of rain fell on the east side of the fire during the afternoon (USDA Northern Region, 1989) dropping the Probabilty of Ignition down to zero percent.

East winds continued to influence the fires. Based on remapping the fire was estimated to be about 36,000 acres (USDA Northern Region, 1989). Later evaluation showed 271 newly burned acres on this date rising the within perimeter fire acreage to 37,430 acres.

1000 hrs. "Visibility poor all around." (Silver King Lookout radio log.)

1008 hrs. "Much activity on Canyon Fire? Can't see in there for blanket smoke. Most activity was Lake Mountain area." (Silver King Lookout radio log.)

1113 hrs. "Middle to high stratus, wind out of north 10-16 MPH, no precipitation." (Silver King Lookout radio log.)

1326 hrs. "Raining on Canyon Creek, head of Dearborn getting pretty wet." (G. Curtis, Tactical Team Leader to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1400 hrs. "Canyon and Gates are socked in due to weather in those areas." (Silver King Lookout radio log.)

1405 hrs. "Socked in on three sides." (Silver King Lookout radio log.)

2000 hrs. "Temperature 44 degrees, wind north 12-18 MPH." (Silver King Lookout radio log.)

Weather Forecast: Canadian cold front coming in from Alberta this afternoon. Winds shifting to north late today. Clear with dry east winds Saturday. Winds decreasing Sunday.

Weather for...Today
Weather...partly cloudy
CWR...below 10%
Temperature...Max valleys 77 ridges 68
Humidity...min 19%
Wind..eye level..Northwest 5 to 10 MPH increasing northerly 15 to 25 late this afternoon.
Weather for...Tonight
Weather...fair
CWR...below 10%
Temperature...low 40's
Humidity...humidity recovery to only 55%
Wind..eye level..northeast 10 to 20 MPH
Outlook for Saturday...Clear. East winds 10 to 20 MPH. High 72. Lowest humidity 18%.

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, Head of the Dearborn River drainage, 1145 hrs. Friday August 26, 1988)

Regional Weather: Skies were mostly clear over the western portion of the Region, and mostly cloudy in the east. Smokey conditions still continued over much of western Montana. Thunderstorms developed over the southeastern corner of the Region with precipitation limited to trace amounts. Scattered lightning was being recorded with 50 discharges between 0600 and 0930 hrs. Overnight low temperatures ranged from 45 at West Yellowstone to 60 degrees at Glasgow. During the afternoon a fast moving Canadian cold front moved through the Region bringing variable cloudiness, some light showers, gusty winds, and cooler temperatures. Wind speeds of 25 to 30 MPH were reported at several locations with a few gusts to 40 MPH. Afternoon winds over Yellowstone National Park were generally west to northwest and were gusting to 35 MPH until 1800 hrs then shifted to the northeast and became light in speed. Low level flow east of the divide in Montana was more northerly. Rainshowers fell at several locations with Great Falls reporting the greatest official amount of .16". Other

unofficial stations in the northcentral portion of the Region recorded .57" at Belly river and 2.2" at St. Mary's. Afternoon temperatures ranged from the mid-50's behind the front to the mid-80's ahead of it. Extremes at 1500 hrs were a cool 56 at Great Falls to a warm 86 degrees at Miles City. Maximum temperatures for the day were mostly in the 70's and 80's, ranging from 75 at Drummond and Lewistown to 93 at Thompson Falls (Bushey, 1989).

AUGUST 27 (Julian Date 240)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 58.3
Seeley Lake Ranger Station; 3-day running mean ERC: 43.6
Gleason's Resort; 3-day running mean ERC: 43.6

For one day the Gleason's Resort Station dropped below the ERC 97th percentile level (ERC = 48).

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 13.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.3%
Gleason's Resort; 3-day running mean 10 Hr: 15.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.6%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.6%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-5%
Monture, 24 hr High-Low range, 10 Hr fuel: 11-6%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-6%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 27-11%

BEHAVE Fuel Moisture:
(West Zone) 24 hr High-Low range, 1 Hr fuel: 9-6% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 7%
24 hr High-Low range, 1 Hr fuel: 10-6% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 7%
(East Zone) 24 hr High-Low range, 1 Hr fuel: 26-7% at 5700 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 10-7%
24 hr High-Low range, 1 Hr fuel: 29-8% at 6800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 10-8%

RAWS Fire Weather: Monture 24 hr temperature range: 52-69F
Monture 24 hr relative humidity range: 29-44%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1500 hrs readings; 66F, 37%)
Benchmark 24 hr temperature range: 36-75F
Benchmark 24 hr relative humidity range: 30-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-11
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):4-22
(Benchmark 1346 hr readings; 75F, 30%, 6 MPH gusts to 14)
(figures 78 - 81)

Fire Behavior: Fire moved over the saddle 2 1/2 miles north of Mineral Hill and started backing downslope to the south into Mineral Creek. The fire had been backing downslope and then making hooking runs back up the slope (Bonney, 1988; USDA Northern Region, 1989). The fire on the west flank of Lake Mountain

Figure 78. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture measurements for August 27 - August 31, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

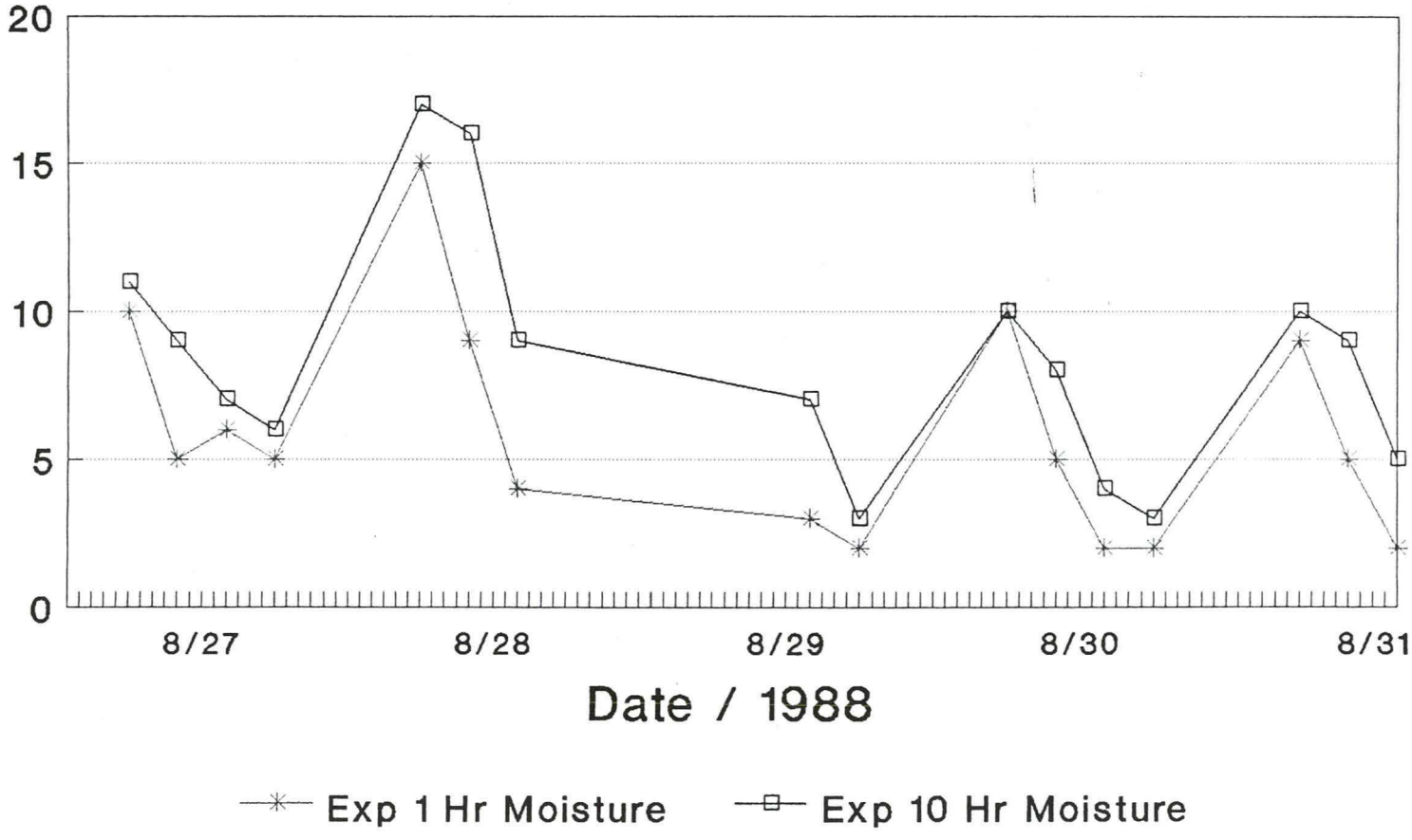


Figure 79. Monture RAWS Station air temperature and relative humidity measurements for August 27 - August 31, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

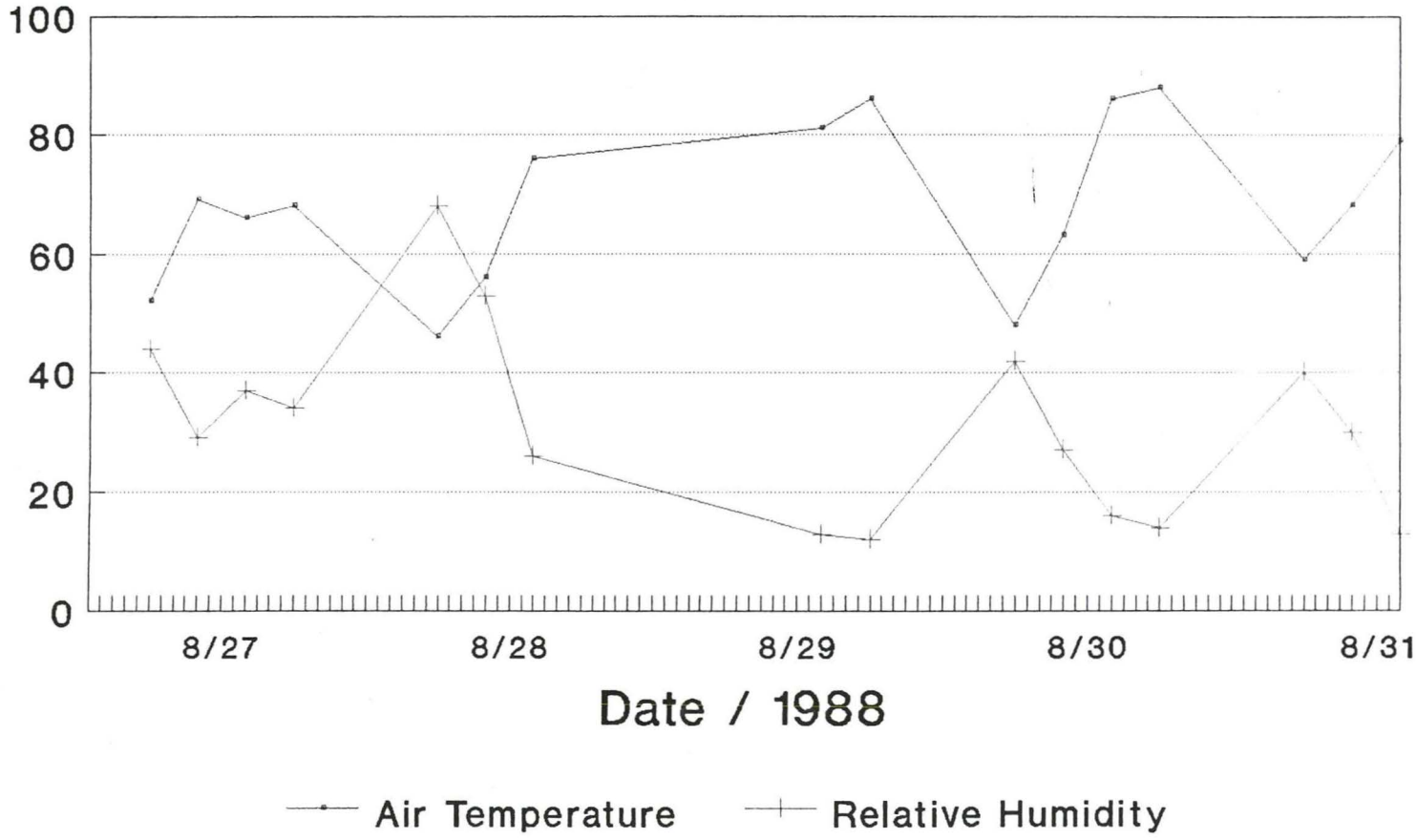


Figure 80. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for August 27 - August 31, 1988 (MST).

Fire Weather
Benchmark RAWS (323331FE)

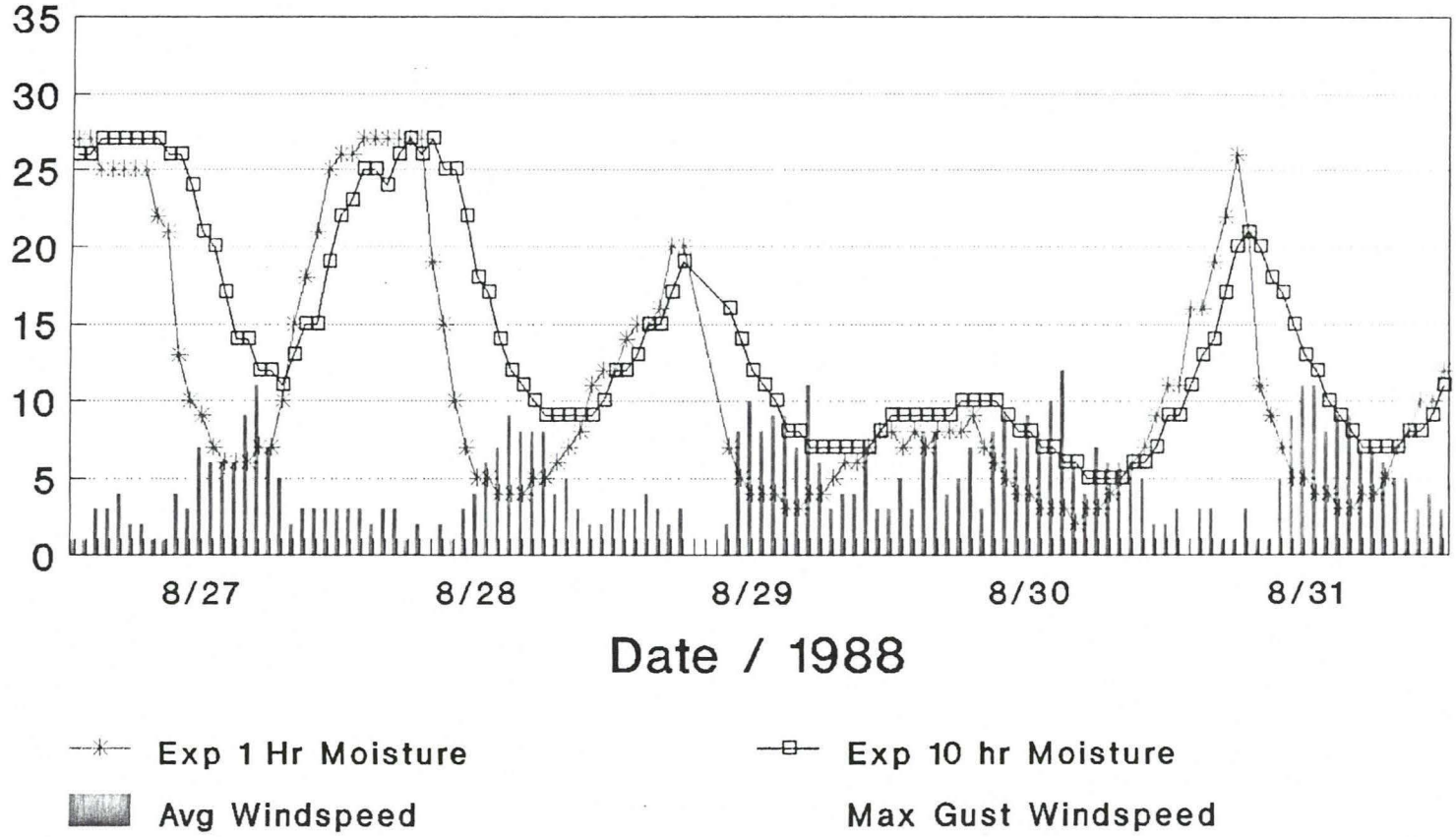
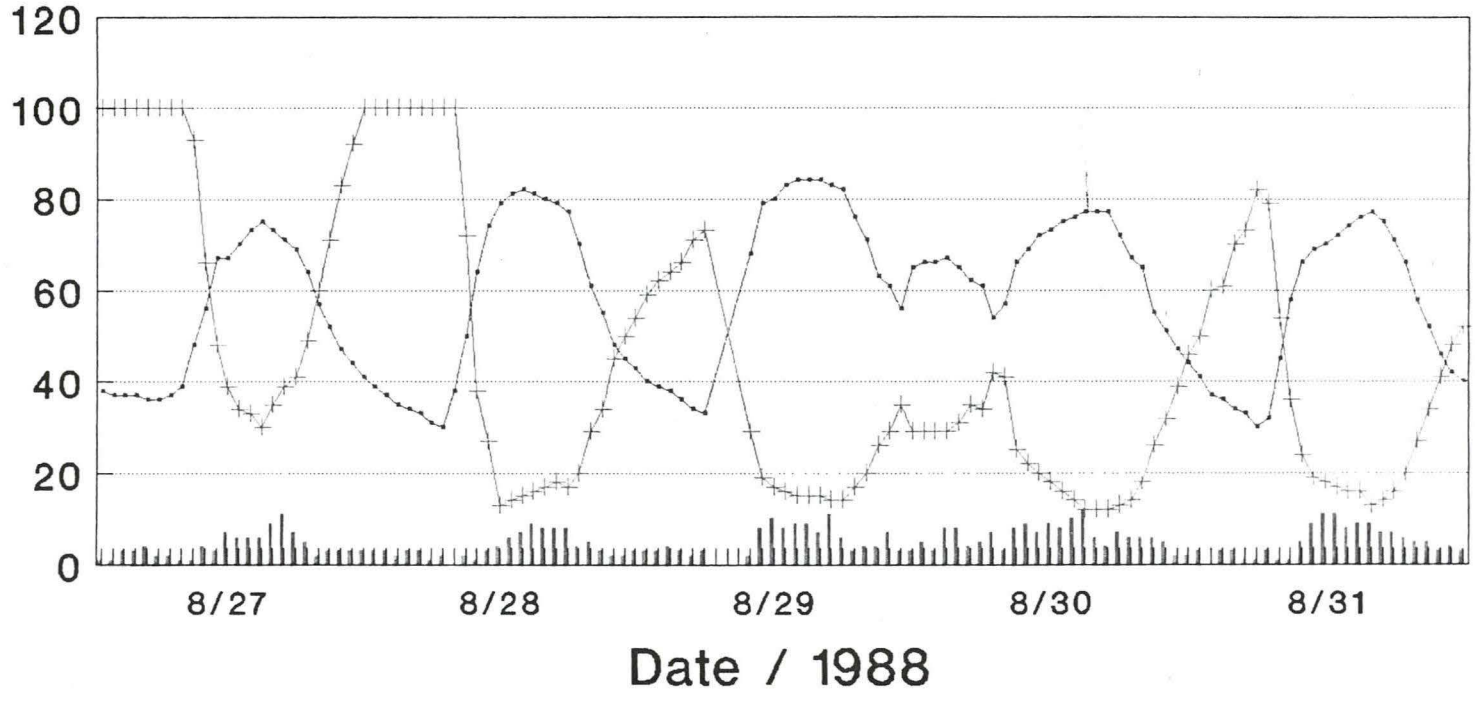


Figure 81. Benchmark RAWS Station air temperature and relative humidity, average wind speed, and maximum gust wind speed measurements for August 27 - August 31, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)



continued to back downslope to the northwest under the influence of an east wind. Probability of Ignition on both the East and West Zones were low with the higher humidities and slightly cooler temperatures, down to 40%. No new fire activity was reported east of the Continental Divide, just continued burning within perimeters. Mapping indicated that 596 acres were added to the fire perimeter bringing the total within perimeter acreage to 38,026 acres.

1355 hrs. "Light activity on Canyon Sections 4 and 9 ridge. Smudge smoke." (Silver King Lookout radio log.)

Weather Forecast: A little cooler today following yesterdays front. High pressure over central Montana today for clear skies and light easterly winds aloft. A little warmer and drier with light southeast winds Sunday.

Weather for...Today
Weather...clear
CWR...zero
Temperature...High valleys 68 ridges 54
Humidity...min valleys 24% ridges 40%
Wind..eye level..easterly and upslope 8 to 16 MPH
Weather for...Tonight
Weather...clear
CWR...zero
Temperature...min valleys 34 ridges 42
Humidity...max valleys 92% ridges 55%
Wind..eye level..southeast 10 MPH
Outlook for Sunday and Monday...Clear. Temperatures up 5 degrees with humidity slightly lower 5%. Winds southeast to south 5 to 12 MPH.

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, Head of the Dearborn Drainage, 1115 hrs. Saturday August 27, 1988)

Regional Weather: Regional skies for the most part cleared during the night, with sunny skies in the morning. Passage of the dry cold front during the night caused cooler nighttime temperatures and higher relative humidities to occur. Morning low temperatures ranged from 34 degrees at West Yellowstone to 51 at Billings. Many other locations reported temperatures in the 30's and 40's. Most locations had northerly winds that were light. Skies remained sunny in the afternoon as a large dome of high pressure built over the Pacific Northwest. This continued the northerly flow, warming in the western portion of the Region while the eastern half was still feeling the effects of the cool air behind the recent passage of the Canadian cold front. Afternoon temperatures were mostly in the 70's in eastern Montana, and in the 80's west of the divide. High afternoon temperatures were mostly in the 70's and 80's, ranging frorom 70 at Broadus and Lewistown to 95 at Thompson Falls. Areas of dense smoke suppressed afternoon high temperatures over southern portions of the Region and in Yellowstone National Park. Locally windy conditions occurred west of the divide with gusts to 20 MPH, but for the most part winds were less than 15 MPH across the Region Of the 44 stations the weather service used to monitor precipitation in Montana, 32 received no moisture during the last week. Another seven stations received 0.05" or less. No measureable precipitation was reported the last week in the southeastern, southcentral and southwestern portions of the Region. Central Montana received the greatest amounts of moisture during the one week time period and had received 49% of its normal precipitation for the growing season (April 1 to the present). Great Falls had received 64%, Stanford 90%, Harlowton 64%, Roundup 51%, and Lewistown

64% of their growing season moisture. In the northcentral portion of the Region Conrad led with 56% of its growing season moisture, while Fort Benton was 51%, Harlem 50%, Cut Bank 63%, Chester 48%, Havre 40%, and Malta with 83%. In the northeast plains Glasgow had received 62%, Medicine Lake 48%, Glendive 22%, Jordan 38%, Poplar 27%, and Sidney 27%. Polson with 113% and Libby at 104% lead northwestern Montana while Thompson Falls had received 93%, Hamilton 111%, Kalispell 88%, and Missoula with 104%. Southwestern Montana was led by Wisdom with 97%, followed by Bozeman with 90%, Belgrade 89%, Dillon 86%, Helena 74%, Lima 71%, West Yellowstone 70%, and Butte with 66%. Red Lodge led the southcentral area with 86%, Livingston 79%, Harlin 70%, Big Timber 70%, Wyola 66%, and Billings 52%. Southeastern Montana had received the least growing season moisture with Ingomar recording 53%, Broadus 39%, Ekalaka 33%, and Miles City at 19% the driest spot (Bushey, 1989).

Long Range Weather Forecast: Three to five day outlook was for a warming, dry trend with scattered showers and a few thunderstorms. Six to ten day outlook was for above normal temperatures and little or no precipitation. Normal high temperatures for this time period are in the 70's (Bushey, 1989).

Miscellaneous: Most of northern Idaho entered into moderate drought from their formerly moist condition as based on the Palmer Drought Severity Index. The rest of the Region and the Yellowstone area remained in areas of extreme soil dryness (Bushey, 1989).

AUGUST 28 (Julian Date 241)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 60.0
Seeley Lake Ranger Station; 3-day running mean ERC: 43.6
Gleason's Resort; 3-day running mean ERC: 51.0

Gleason's Resort again moved above the ERC 97th percentile level and would stay above this level until September 10th.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 12.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.3%
Gleason's Resort; 3-day running mean 10 Hr: 8.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 12.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 15-4%
Monture, 24 hr High-Low range, 10 Hr fuel: 17-9%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 27-9%

BEHAVE Fuel Moisture:
(West Zone) 24 hr High-Low range, 1 Hr fuel: 13-7% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 7%
24 hr High-Low range, 1 Hr fuel: 15-9% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 9%

(East Zone) 24 hr High-Low range, 1 Hr fuel: 21-4% at 5700 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%
24 hr High-Low range, 1 Hr fuel: 23-5% at 6800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

RAWS Fire Weather: Monture 24 hr temperature range: 46-76F
Monture 24 hr relative humidity range: 26-68%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1500 hrs readings; 76F, 26%)
Benchmark 24 hr temperature range: 30-82F
Benchmark 24 hr relative humidity range: 13-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-9
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):3-20
(Benchmark 1346 hr readings; 81F, 16%, 9 MPH gusts to 18)

Fire Behavior: On the west side the fire continued to back down Madison Creek and also down the ridge above Madison Creek against a southerly wind flow. Continued upslope runs occurred within the unburned area north of the fire's origin expanding the fire in that region further to the northwest of the Dry Fork, and also within a small area on the east side of the Dry Fork about 2 miles northwest of the origin. With the continued cool temperatures and moderate humidities the West Zone Probability of Ignition only rose to 40% during the afternoon peak burning period. Warming afternoon temperatures and dropping humidities on the East Zone caused the peak afternoon burning period Probability of Ignition to climb to 60 - 70%. However, no new perimeter expansion was reported from the East Zone. Fire was estimated to be about 37,000 acres (USDA Northern Region, 1989). Digitized mapping of the fire would later show that about 322 acres had been burned on this date causing the within perimeter fire acreage to climb to 38,349 acres.

1200 hrs. "Winds calm south at 5. Little activity on Canyon." (Silver King Lookout radio log.)

1220 hrs. A spot fire at the head of Lost Cabin Creek made a run with strong gusty winds out of the west-southwest. Retardant drops were effective.

1220 hrs. "Fire at head of Lost Cabin Creek is making a run need people to Elk Creek helibase ASAP." (Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1237 hrs. "45 acres, heading northwest." (Transmission from the Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1300 hrs. Kamard reported spots east of the Continental Divide. Crews worked the night on spots east of the Dearborn River.

1355 hrs. "Moderate activity on Canyon." (Silver King Lookout radio log.)

1430 hrs. "Activity increasing Mineral Hill (Mountain) area and Lake Mountain." (Silver King Lookout radio log.)

1605 hrs. "Four large columns on Canyon." (Silver King Lookout radio log.)

1845 hrs. "Fire has quieted down. Spot on upper Dearborn has quieted especially after retardant drop." (Augusta Information Station, radio log.)

Regional Weather: A strong ridge of high pressure aloft continued to be the dominate weather feature. The ridge axis was centered along the Washington and Idaho border. The surface pattern over the Region was very flat and the flow aloft quite weak. Most valleys were experiencing moderate temperature inversions during the morning and smoke was pooling beneath the inversion in many valleys of western Montana and northern Idaho. The temperature inversions were several hundred feet in depth and usually broke between 1100 - 1200 hrs with the development of light breezes. More exposed sites were breaking earlier (0930 - 1000 hrs). The subsidence inversion dropped considerably closer to the surface during the morning. Over the western mountains the layer of dry air was at approximately 9,000 ft, then dropped to 6,500 ft over the northern plains. Visibility was markedly reduced; West Yellowstone, Montana and Burley, Idaho reported visibility of only 3 miles, Idaho falls and Mountain Homes in Idaho reported 5 miles, Pocatello (Idaho) 6 miles, and Boise (Idaho) 7 miles. During the night temperatures fell into the 40's and 50's, and at 0600 hrs ranged from 30 at West Yellowstone to 56 at Miles City. Sunny and dry with light winds across Montana during the afternoon. Thompson Falls had the days high temperature reading of 100 degrees, Plentywood was the coolest at 73 (Bushey, 1989).

AUGUST 29 (Julian Date 242)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 62.6
Seeley Lake Ranger Station; 3-day running mean ERC: 44.6
Gleason's Resort; 3-day running mean ERC: 54.0

The Lincoln Ranger Station again exceeds the ERC 90th percentile level based on the Fire Management Plan and will remain at or above this level until September 10th, a period of 12 days.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.6%
Gleason's Resort; 3-day running mean 10 Hr: 6.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 12.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel:insufficient data
Monture, 24 hr High-Low range, 10 Hr fuel: insuf. data
Benchmark, 24 hr High-Low range, 1 Hr fuel: 20-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 19-7%

BEHAVE Fuel Moisture:
(West Zone) 24 hr High-Low range, 1 Hr fuel: 12-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 13-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
(Moisture values are estimated for the West Zone based on persistent trends.)

(East Zone) 24 hr High-Low range, 1 Hr fuel: 12-4% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 13-4% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%

RAWS Fire Weather: Monture 24 hr temperature range: no data-86F
Monture 24 hr relative humidity range: 12-no data
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1500 hrs readings; 81F, 13%)
Benchmark 24 hr temperature range: 33-84F
Benchmark 24 hr relative humidity range: 15-73%
Benchmark 24 hr average 20 ft wind speed range (MPH): 2-11
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):5-26
(Benchmark 1346 hr readings; 84F, 15%, 9 MPH gusts to 20)

Fire Behavior: Strong thermal belt conditions were being experienced in the higher elevations, aggravating nighttime burning conditions. Fuel moisture recovery during the previous night had been poor as the subsidence inversion again shifted back over the Northern Rocky Mountains. Approximately 1200 hrs the fire in the middle of Lost Cabin Creek in the East Zone began to flare up and burn downslope toward the Dearborn River. Within an hour it was also starting to run near the mouth of the same drainage. Under the influence of increasingly gusty up drainage and upslope winds trees began to torch on the north side of the mouth of the drainage. Fire further up stream in Lost Cabin Creek started to move to the northwest under the now stronger upslope wind influence. Moving in these two directions the fire would eventually spot across the Dearborn River, as well as continue to burn up drainage toward the ridge separating Lost Cabin and Cave Creeks.

The spot across the Dearborn quickly moved up the slope toward the Wilderness Boundary, the ridgetop above the east side of the Dearborn River. The fire once it reached the ridgetop crossed a previously blasted fireline. The slope and ridgetop were an area of less dense conifers with a heavier grass understory for fuel. The fire spread along the ridgetop then downslope with the prevailing winds into heavier fuel within the Jakie Creek and Weasel Creek drainages. Probability of Ignition during the afternoon on the East Zone peaked at 70%.

During the time while the fire was making its run beyond the wilderness boundary to the northeast, the fire also continued to actively burn up Lost Cabin Creek drainage and side drainages with the main fire in this area moving to the northwest. The fire spread in Lost Cabin Creek was a slow moving crown fire spreading by radiant heat from tree crown to tree crown, moving against the slope and prevailing general winds. Both fire areas on either side of the Dearborn River burned all night. Light was sufficient from the fire in Lost Cabin Creek to read inside the Welcome Creek Guard Station during much of the night (Collins interview). Fuel moistures stayed low throughout the night.

The west side zone of the fire was relatively inactive as the fire burned areas within the perimeter interior and continued to back down the southern slope of Lake Mountain.

An additional 7,824 acres were burned during this day's activity, mostly on the east side of the Dearborn River. The within perimeter fire acreage expanded to 46,172 acres.

0700 hrs. "Clear, 56 degrees, wind southwest / west 8-14 MPH. Blanket smoke over Canyon. Could see moderate activity most of night on eastern edges. Valley smoke could cause visibility problem later." (Silver King Lookout radio log.)

0730 hrs. No smoke was showing from the spot at the head of Lost Cabin Creek or along the south line from the Dearborn to the Continental Divide. The Dearborn drainage was smoked in. Williams hiked up the Lake Mountain trail and reported that the fire was north of a rock slide lying to the east and above decadent ABLA stand with heavy fuel (USDA Northern Region, 1989).

1000 hrs. "Visibility 5 mile radius." (Silver King Lookout radio log.)

1200 hrs. "Visibility still poor, wind west / northwest 10-18 MPH." (Silver King Lookout radio log.)

1216 hrs. "North end of Lost Cabin Creek is flaring up." (Augusta Information Station, radio log.)

1230 hrs. Smoke was building on the east side of the fire.

1300 hrs. Fire was starting to run in the mouth of Lost Cabin Creek in areas of scattered trees and large quanities of dead and down drift wood and log jams in the drainage bottoms (Collins interview).

1315 hrs. "Winds pickup west / northwest 16-20 MPH. Can see column; Lake Mountain, Mineral Hill (Mountain)." (Silver King Lookout radio log.)

1325 hrs. Trees torched on the north side of Lost Cabin Creek because of warm, gusty winds from the southwest. Fire in this area would move both to the north up the Dearborn River and to the southwest up the mouth of Lost Cabin Creek (Collin interview).

1325 hrs. "West end of Lost Cabin Creek really blowing up." (Augusta Information Station, radio log.)

1400 hrs. "Moderate activity on Canyon, visibility poor." (Silver King Lookout radio log.)

1430 hrs. Fire was burning more intensely in the Dearborn and Lost Cabin Creek drainages (USDA Northern Region, 1989).

1451 hrs. "(Fire) crossed Lost Cabin Creek down to Dearborn; prevailing winds, approximately 1/4 mile (from) Dearborn; estimate in next hour will be at Dearborn." (Augusta Information Station, radio log.)

1523 hrs. "It has crossed Lost Cabin Creek headed for the Dearborn. It's crossed Dearborn. Everyone is safe. May lose Welcome Creek Cabin." (Welcome Creek Guard Station to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1535 hrs. The fire was reported to have spotted across the Dearborn just to the north of Pass Creek Drainage. Within 15-20 minutes the fire had burned a narrow 12-15' strip straight up the slope to the ridgeline (Wilderness Boundary). From that point the fire spread rapidly down into the northeast facing drainages running into Elk Creek (Collins and Sisk interviews).

1535 hrs. "Cross Dearborn at Lost Cabin Creek, bad situation." (Collins to Choteau Ranger Station, Augusta Information Station radio log.)

1540 hrs. "The mouth of Lost Cabin Creek is in flames spotting across but spots are burning back into the fire." (Welcome Creek Guard Station to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1550 hrs. "Burned down thru Lost Cabin Creek; spots burning on each other." (Augusta Information Station, radio log.)

1609 hrs. "Crossed Dearborn but moving slow." Aerial observer to the Augusta Information Station, radio log.)

1630 hrs. Fire had moved across the Dearborn and was moving up the east side of the river.

1830 hrs. At the head of Jakie Creek and Weasel Creek the fire was 1/4 to 1/2 mile into heavy, down fuel.

1830 hrs. "Fire across blasted line to the east (over Wilderness Boundary)." (Aerial observer to the Augusta Information Station, radio log.)

2145 hrs. "Burning intensively and extensively in the Creek east side of Dearborn (Pass Creek)." (Welcome Creek Guard Station to the Augusta Information Station, radio log.)

2226 hrs. "Fire burning intensely." (Transmission from the Welcome Creek Guard Station to the Augusta Information Station, radio log.)

2230 hrs. "Can see flare up, Section 3, T16N, R7W, Continental Divide. Difficult to see due to smoke." (Silver King Lookout radio log.)

2250 hrs. "Doesn't seem to be growing, 1 acre. Wind west / northwest 14-18 MPH." (Silver King Lookout radio log.)

2300 hrs. "Going to get 67 Mike (aerial recon) in morning. Sure it isn't glow from Canyon? Negative." (Silver King Lookout radio log.)

2300 hrs. A status report said the fire was spotting and burning near Elk Pass and Bunchgrass Creek (USDA Northern Region, 1989).

2328 hrs. "Possible spot fire, can see flames from trailhead. Will monitor." (Elk Creek Camp transmission to the Augusta Information Station, radio log.)

2400 hrs. "Wind picking up from the west. Appears to be fire activity in bottom of Bunchgrass (Creek), head end of Blubber Creek, active within 3/4 mile of trailhead. Flame area has doubled since (observer has) been there." Elk Creek Camp. (Augusta Information Station, radio log.)

2400 hrs. Confirmed that the fire was outside the wilderness boundary and that it was burning intensely (200 ft flame lengths) and spotting 1/4 to 1/2 mile at night with winds west to southwest 30-35 MPH. The fire was now approximately 51,200 acres (USDA Northern Region, 1989)

Regional Weather: Temperature during the night dropped into the 30's and 40's, ranging from 30 degrees at West Yellowstone to 58 recorded in Boise. At 0600 hrs the subsidence inversion over the mountains varied between 8,500 and 13,000 ft in elevation between Spokane and Great Falls. Sunny skies and smoke in the valleys were the features of the day. Brisk west winds began blowing at Missoula at 1700 hrs and cleared the smoke out of the valleys. This wind was associated with a weak dry Pacific front approaching the area. This breeze possibly prevented Missoula from tying the temperature record for the date which was 94 degrees (1936, 1948). High temperatures during the afternoon were mostly in the 90's, ranging from 100 degrees at Thompson Falls to 82 at West Yellowstone. A Red Flag was issued for the Yellowstone Park area for tonight and tommorrow for winds associated with the approaching dry cold front.

Of the last 45 days in Missoula only 3 days had measurable rain. Helena reported the 33rd day with 90 or higher temperatures, breaking a record for that many days in any one year. This broke a record achieved in 1967. Their records have been maintained since 1880 (Bushey, 1989).

Long Range Forecast: The three to five day outlook indicated a warming and drying trend. The six to ten day outlook called for temperatures above normal and precipitation below normal. Normal high temperatures for this time of the year are in the 70 to 80 degree range (Bushey, 1989).

AUGUST 30 (Julian Date 243)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 65.0
Seeley Lake Ranger Station; 3-day running mean ERC: 45.3
Gleason's Resort; 3-day running mean ERC: 56.6

The Lincoln Ranger Station again has an ERC level above the 97th percentile (ERC = 63) based on the 1973-1987 seasons. This level will be exceeded for the next eleven days, until September 10th.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.3%
Gleason's Resort; 3-day running mean 10 Hr: 5.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.6%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 12.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 10-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 9-2%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 10-5%

BEHAVE Fuel Moisture:

(West Zone)	24 hr High-Low range, 1 Hr fuel: 8-3% at 5600 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 3%
	24 hr High-Low range, 1 Hr fuel: 10-3% at 7800 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 3%
(East Zone)	24 hr High-Low range, 1 Hr fuel: 7-4% at 5200 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
	24 hr High-Low range, 1 Hr fuel: 9-4% at 7200 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%

RAWS Fire Weather: Monture 24 hr temperature range: 48-88F
Monture 24 hr relative humidity range: 14-42%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1500 hrs readings; 86F, 16%)
Benchmark 24 hr temperature range: 54-77F
Benchmark 24 hr relative humidity range: 12-46%
Benchmark 24 hr average 20 ft wind speed range (MPH): 2-12
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):7-28
(Benchmark 1346 hr readings; 77F, 12%, 12 MPH gusts to 24)

Fire Behavior: After the fire crossed over the Dearborn and the next ridge above the river the fire had relatively gentle terrain to burn in. During the night the fire worked its way down Jakie and Weasel Creeks then would make runs up drainages that connected with these. Fire was mostly a surface fire with considerable torching. During the early morning driven by strong, gusting winds out of the southwest the fire crossed the saddle on the east boundary of the wilderness on to the Lewis & Clark National Forest. By 0800 hrs there was fire in the head of Jakie Creek, Weasel Creek, Elk Pass, Bunchgrass and Horse Mountain. As the fire continued downslope the terrain became increasingly rough with large areas of mineral soil. The fire became scattered in many different drainages with no particular front. During the day line was constructed up Sawmill Gulch to Blubber Creek and past. Winds were southwest / west / northwest. The fire was making some crown runs on the interior but had mostly stopped making any strong advances. About 1600 hrs fire threatened Elk Creek Road by Elk Creek Ranch. Burnout operations were conducted in rough fescue grasslands, fire behavior was 10-12 ft flame lengths as the fire burned into the wind and upslope, very rapid rates-of-spread, eye level winds out of northwest at a steady 10 MPH. When the fire would reach Fuel Model H adjacent to the mountain meadows the fire would burn spotty and creep through the duff, would not carry into lodgepole pine crowns. Fire had also entered into Cataract Basin but wasn't burning very intensely (Peila interview). By the end of the day about 7000 acres of non-wilderness lands and 80 acres of private lands had burned.

After burning all night a backing crown fire continued to burn in the upper portions of Lost Cabin Creek where it crossed the ridge into the head of the Dearborn River drainage. At about 1200 hrs the fire was burning northwest on a line approximately half way downslope on the northwest facing aspect in the Dearborn drainage from about 1.5 miles up into Cave Creek (Collin interview). Probability of Ignition during the peak afternoon burning hours rose to 70% in the East Zone.

In the Madison Creek and Lake Creek trail areas the fire was backing into the wind at less than 1 ch/hr. Some torching of sapling sized trees by radiant heat in advance of the backing flame front occurred along with torching of 60% to 80% of pole sized trees by convection as the flaming front backed through.

Control problems were experienced because of the intensity of the fire (estimated at 1500 H/A) and dryness of the fuel (Probability of Ignition 90%) causing escapes below the control lines (Carlson, 1988). This fire had spread down Lake Mountain and in to Madison Creek about 1/2 way down the south slope. On the east side of Lake Mountain it was on the edge of the North Fork of the Blackfoot River but still on the river's west side. Afternoon extreme burning conditions on this side of the fire were DB 80-85F, RH 15-25%, winds southwest 10-15 MPH (Carlson, 1988). During this time the West Zone Probability of Ignition at all elevations climbed to 80% under the continued trend of warming, dry afternoon weather.

An additional 7,667 burned acres were mapped for nearly 15,500 acres during the last 48 hrs. Within fire perimeter acreage expanded to 53,840 acres.

0100 hrs. "Orange glow visible from back door of office (Augusta Information Station) to west of Haystack (Butte)." (Augusta Information Station, radio log.)

0100 hrs. DB 78, RH 28%, winds west-southwest at 30+ and gusty. (Fire Weather from the Elk Creek Division.)

0130 hrs. "Leslie Goss reports her husband saw flames on ridge head of Goss Creek and Smith Creek from vicinity of "Red Barn" at L-F Ranch." Later (0357 hrs) Mr. Goss would again phone with a better description, "At about 1 AM saw flames on ridge SE1/4, SEction 32, T19N,R8W from a hill in Section 14. Spots a couple 100 feet long would flare up then glow. Smoke then going east, now pretty much going north." [Note; Goss's are a local ranching family.] (Augusta Information Station, radio log.)

0137 hrs. "Heading down off Horse Mountain to go over maps. Southwest winds on top, but fire mostly moving north rather than northeast." McBratney to G. Curtis, Tactical Team Leader. (Augusta Information Station, radio log.)

0230 hrs. "Looks like its coming over the top of Elk Pass, spotted toward Smith Creek." Tom Cockerhran, monitor on Horse Mountain with McBratney, after arrival back at Augusta Information Station. (Augusta Information Station, radio log.)

0510 hrs. "Pulled all stops, all out control." (Rocky Mountain District, Lewis and Clark National Forest, radio log.) [Note; Canyon Creek Fire is declared a wildfire.]

0600 hrs. "Can you see anything on fire spotted? Negative, smoke has area socked in." (Silver King Lookout radio log.)

0640 hrs. "Visibility good and winds calm." Welcome Creek Guard Station. (Augusta Information Station, radio log.)

0645 hrs. "Vision better, but still can't seen anything." (Silver King Lookout radio log.)

0825 hrs. "Have smoke sighted, Blowout Mountain." (Silver King Lookout radio log.)

0830 hrs. "Heli attack more than 3 people, heavy timber, lots of saw work, 1 acre +." (Silver King Lookout radio log.)

0910 hrs. "Winds west 16-22 MPH." (Silver King Lookout radio log.)

0915 hrs. "Fire has quieted down, 300 yards from cabin directly north, 1/4 mile west up drainage; periodic crowning little wind, 5 gusting 10 (MPH)." (Transmission from the Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1020 hrs. "1/4 mile from helibase (located on divide; Section 20, T18N, R9W) black smoke, GET OUT." (Augusta Information Station, radio log.)

1023 hrs. "Fire right above helibase." (Transmission from Peila to the Augusta Information Station, radio log.)

1059 hrs. "Perimeter 1/2 mile up Elk Creek road, Sections 10 and 11." (Transmission from Peila to the Augusta Information Station, radio log.)

1145 hrs. "Column of smoke southwest of cabin." (Transmission from Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1155 hrs. "Two acres, two spots, 50 yards. Fire down." (Silver King Lookout radio log.)

1429 hrs. "Several major fires burning; head of Lost Cabin Creek burn(ed) out ridge between Dearborn and Lost Cabin Creek, 5 miles up Dearborn from Welcome Creek both south and north sides Dearborn threatened tonight." (Augusta Information Station, radio log.)

1500 hrs. "Winds west / southwest 10-18 MPH, gusts low 20's." (Silver King Lookout radio log.)

1513 hrs. "Column south of Welcome Creek pass; pull back to road system....Smith Creek down canyon winds; potential if gets out Jackie (Creek); is north of Weasel and Jakie (Creeks); ridge between Weasel and Jackie (Creeks); big column up behind Jakie Creek." (Augusta Information Station, radio log.)

1530 hrs. "Winds west / southwest 14-20 MPH, gusts low 20's. Heavy blanket of drift smoke from Canyon Fire starting to settle in area." (Silver King Lookout radio log.)

1551 hrs. "Burnout in Elk Creek, request air traffic for emergency use only." Peila. (Augusta Information Station, radio log.) [Note; burnout operations continued until at least 2018 hrs based on radio communications.]

1555 hrs. "300 yards, crowning, moving cats out." (Transmission from Peila to the Augusta Information Station, radio log.)

1600 hrs. "Winds west 12-16 MPH, gusting to 22." (Silver King Lookout radio log.)

1630 hrs. "Winds increasing west / northwest 16-24 MPH, gusting to 28." (Silver King Lookout radio log.)

1800 hrs. "Smokey to northwest / north / northeast of Silver King. Winds west 14-18 MPH gusting low 20's." (Silver King Lookout radio log.)

Weather Forecast: Brisk low level winds will continue, especially higher elevations into the evening. Higher pressure building over the area will lead decreasing winds on Wednesday.

Weather for...Tonight
Weather...clear but smokey
Temperature...Minimum near 40 in the valleys, 45-50 mid and upper slopes
Humidity...Recovery to 70% valley bottoms, 45-55% mid and upper slopes
Wind..eye level..mostly downslope 3-6 by dark, gusty higher ridges until midnight

Weather for...Wednesday
Weather...sunny
Temperature...High 80-85 valleys, 75-80 ridges
Humidity...15-25%
Wind..eye level..westerly 6-12 exposed sites by 11AM, gusty during afternoon from the west to northwest 15-25 MPH

Outlook for Thursday...Sunny and warmer...light winds

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, 1500 hrs. Tuesday August 30, 1988)

Regional Weather: A weak upper trough of low pressure over the Northern Rocky Mountains produced gusty winds and slightly cooler temperatures. Temperature during the night cooled into the 50's and 60's over most of Montana, and ranged at 0500 hrs from 70 at Great Falls to 46 degrees at Butte. However temperatures were still above normal for this time of the year. Winds in the Yellowstone area reached 40 MPH as another dry cold front passed through. At 1730 hrs the entire Northern Rocky Mountain and Great Plains areas had clear skies as indicated by radar. However, at this time three large convection columns were evident over Yellowstone National Park and were interpreted to be at least 20,000' to over 25,000' in elevation. Location of the columns indicated the North Fork Fire, Clover / Mist Fire and the Mink Fire were the sources. A report from the North Fork Fire indicated the cumulus capped convection column was producing light "sprinkles" of rain (Bushey, 1989).

Long Range Weather Forecast: Three to five day outlook was for fair weather that would be warmer and drier than normal. The six to ten day outlook indicated continued above normal temperatures and below normal precipitation (Bushey, 1989).

AUGUST 31 (Julian Date 244)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 67.3
Seeley Lake Ranger Station; 3-day running mean ERC: 45.3
Gleason's Resort; 3-day running mean ERC: 58.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.6%
Gleason's Resort; 3-day running mean 10 Hr: 4.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.3%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.6%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 9-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 10-5%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 26-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 21-7%

BEHAVE Fuel Moisture:
(West Zone) 24 hr High-Low range, 1 Hr fuel: 8-3% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 3%
24 hr High-Low range, 1 Hr fuel: 8-3% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 3%
(East Zone) 24 hr High-Low range, 1 Hr fuel: 13-5% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
24 hr High-Low range, 1 Hr fuel: 16-5% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

RAWS Fire Weather: Monture 24 hr temperature range: 59-79F
Monture 24 hr relative humidity range: 13-40%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1500 hrs readings; 79F, 13%)
Benchmark 24 hr temperature range: 30-77F
Benchmark 24 hr relative humidity range: 13-82%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-11
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):2-24
(Benchmark 1346 hr readings; 76F, 16%, 9 MPH gusts to 20)

Fire Behavior: In the Madison Creek area the fire continued to back into the wind at the same intensity as the day before. Also, active fire behavior was taking place in the basin in Section 34 west-northwest of Lake Otatsy and along the ridgeline in Section 4 just south of Section 34. In both cases the fire behavior was a very active backing fire. Line lost the previous day was picked up by the end of the shift. Extreme afternoon burning conditions on the west zone of the fire were DB 80-85F, RH 15-20%, and southwest winds 10-15 MPH (Carlson, 1988). Probability of Ignition on the West Zone continued to be 80% during the afternoon burning period.

Near the Dearborn River the fire had burned within 1 mile of the Welcome Creek Cabin (USDA Northern Region, 1989). Burnout operations continued in the Blubber Creek drainage with upslope easterly winds (Peila interview). Probability of Ignition climbed to 60% during the day on the East Zone.

Compared to recent days the 500 newly burned acres on this date was a relatively small total. Within perimeter fire acreage rose to 54,340 acres.

0700 hrs. "Looks clear, smokey. Very poor visibility, temperature 45 degrees. Wind north / northwest 10-18 MPH." (Silver King Lookout radio log.)

0745 hrs. "Fire layed down (fire on Blowout Mountain), lots of hot spots." (Silver King Lookout radio log.)

1200 hrs. "Poor visibility." (Silver King Lookout radio log.)

1800 hrs. "Visibility improving some." (Silver King Lookout radio log.)

Weather: Temp 80-85, RH 15-20, Winds southwest 10-15 (Carlson, 1988)

Weather Forecast: High pressure ridge moving in from Washington and Oregon. Wind flow turning light northerly. Warm dry weather with fairly light winds next 72 hours. There is a strong temperature inversion at 8500 feet elevation with very dry air above this inversion. This inversion will lower a little, to 6500 to 7000 feet Thursday and Friday which means dry air and poor humidity recovery above 6500 feet Thursday and Friday nights.

Weather for...Today
Weather...clear
Temperature...Max 79 at 5000 ft...66 at 8000 ft
Humidity...min 5000 ft 15%...8000 ft 18%
Wind..eye level..upslope 3 to 7 MPH to light westerly 6-7 MPH
Weather for...Tonight
Weather...clear
Temperature...min 38 at 5000 ft..42 at 8000 ft
Humidity...max 5000 ft 65%..8000 ft only 42%
Wind..eye level..light northerly 4 to 8 MPH
Outlook for Thursday...Sunny warm and dry. High 5000 feet 83 and 8000 feet 69 with lowest afternoon Humidity 13% 5000 ft and 17% 8000 ft. General winds very light northerly 4 to 8 MPH with winds on the fire mostly upslope 3 to 6 MPH. (Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, 1200 hrs. Wednesday August 31, 1988)

Regional Weather: High pressure building over the Region contributed to clear and dry morning skies, with temperatures cooler than previous mornings. In eastern Montana 10 MPH winds helped keep morning temperatures slightly warmer. Morning temperatures ranged from the upper 30's in Butte to the lower 60's at Miles City. The layer of very dry air (subsidence inversion) was between 8,000 - 12,000 ft with another layer of dry air over that between 12,000 - 15,000 ft. During the afternoon, sunny skies with light winds predominated across Montana. Early afternoon temperatures warmed into the mid-70's to low 80's. At 1700 hrs extremes ranged from 77 degrees at Butte to 90 degrees at Thompson Falls and 86 at Billings. In Idaho afternoon temperatures were mostly in the 80's with Mountain Home reporting 91 (Bushey, 1989).

Long Range Weather Forecast: The three to five day outlook was for hot and dry. The six to ten day period was predicted to have temperatures much above normal with no precipitation. Normal high temperatures for this period are in the 70's (Bushey, 1989).

SEPTEMBER 1 (Julian Date 245)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 69.0
Seeley Lake Ranger Station; 3-day running mean ERC: 44.6
Gleason's Resort; 3-day running mean ERC: 60.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.3%
Gleason's Resort; 3-day running mean 10 Hr: 4.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel:insufficient data
Monture, 24 hr High-Low range, 10 Hr fuel:insuf. data
Benchmark, 24 hr High-Low range, 1 Hr fuel: 24-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 21-6%

BEHAVE Fuel Moisture:

(West Zone)	24 hr High-Low range, 1 Hr fuel: 9-4% at 5600 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
	24 hr High-Low range, 1 Hr fuel: 10-5% at 7800 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
(East Zone)	24 hr High-Low range, 1 Hr fuel: 14-4% at 5200 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
	24 hr High-Low range, 1 Hr fuel: 17-4% at 7200 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%

RAWS Fire Weather: Monture 24 hr temperature range: insuf. data
Monture 24 hr relative humidity range: insufficient data
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1500 hrs readings; 77F, 17%)
Benchmark 24 hr temperature range: 29-85F
Benchmark 24 hr relative humidity range: 11-84%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-7
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):2-20
(Benchmark 1346 hr readings; 84F, 11%, 7 MPH gusts to 16)
(figures 82 - 85)

Fire Behavior: In the area of the North Fork of the Blackfoot and H1 Ridge (ridge between Madison Creek and the North Fork of the Blackfoot River) a large spot fire occurred during the night, evidently driven by down canyon winds, the spot fire backed into the river trail along the Blackfoot River. At 0930 up canyon (southwest) winds started driving the fire upriver toward the packbridge. Rate-of-spread averaged 9 chs/hr with frequent torching. Also, at this time the fire started backing sporadically sidehill to the south along the east side of the ridge between Madison Creek and the Blackfoot River challenging the control line. The control line established in Madison Creek prevented any more downhill spread (Carlson, 1988). In the morning water drops were used on the fire burning just west of the North Fork immediately adjacent to the river, this activity kept the fire from spreading on the east side of

Figure 82. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for September 1 - September 5, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

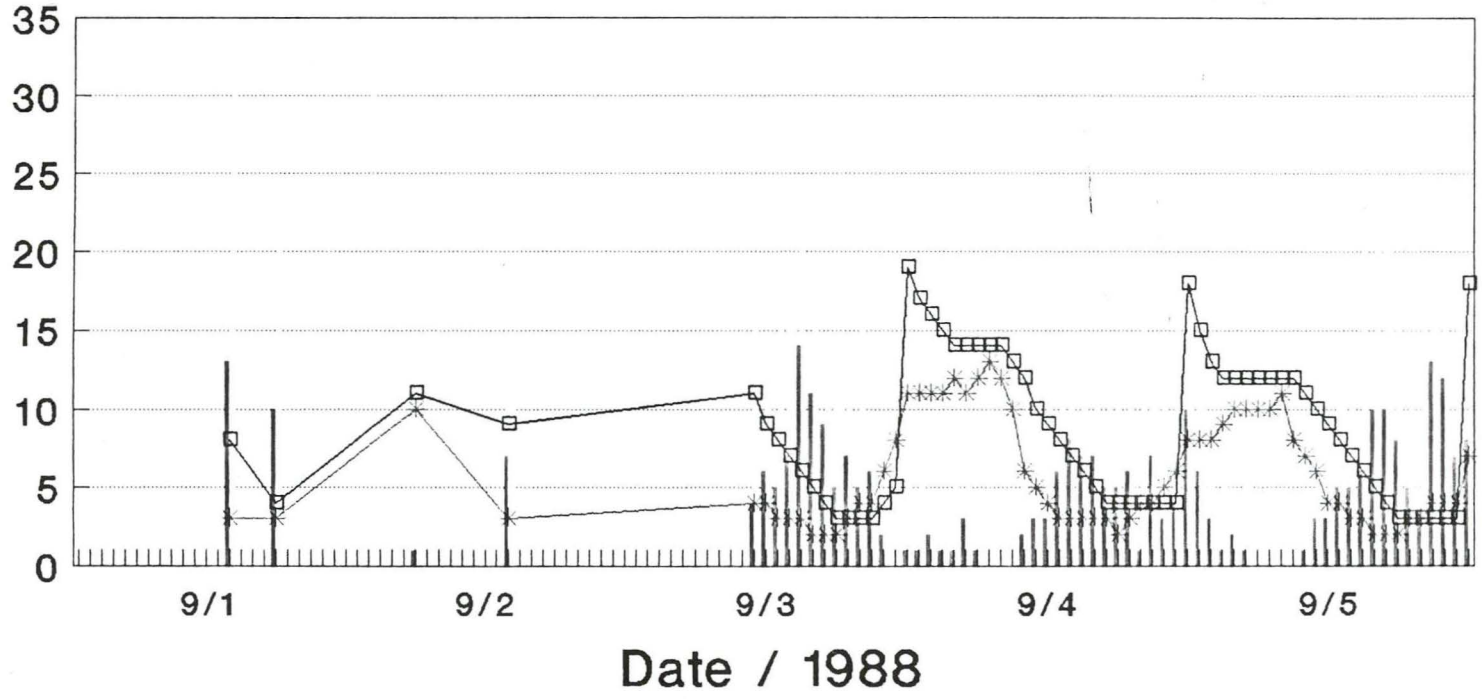


Figure 83. Monture RAWS Station air temperature, relative humidity, average wind speed, and maximum gust wind speed measurements for September 1 - September 5, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

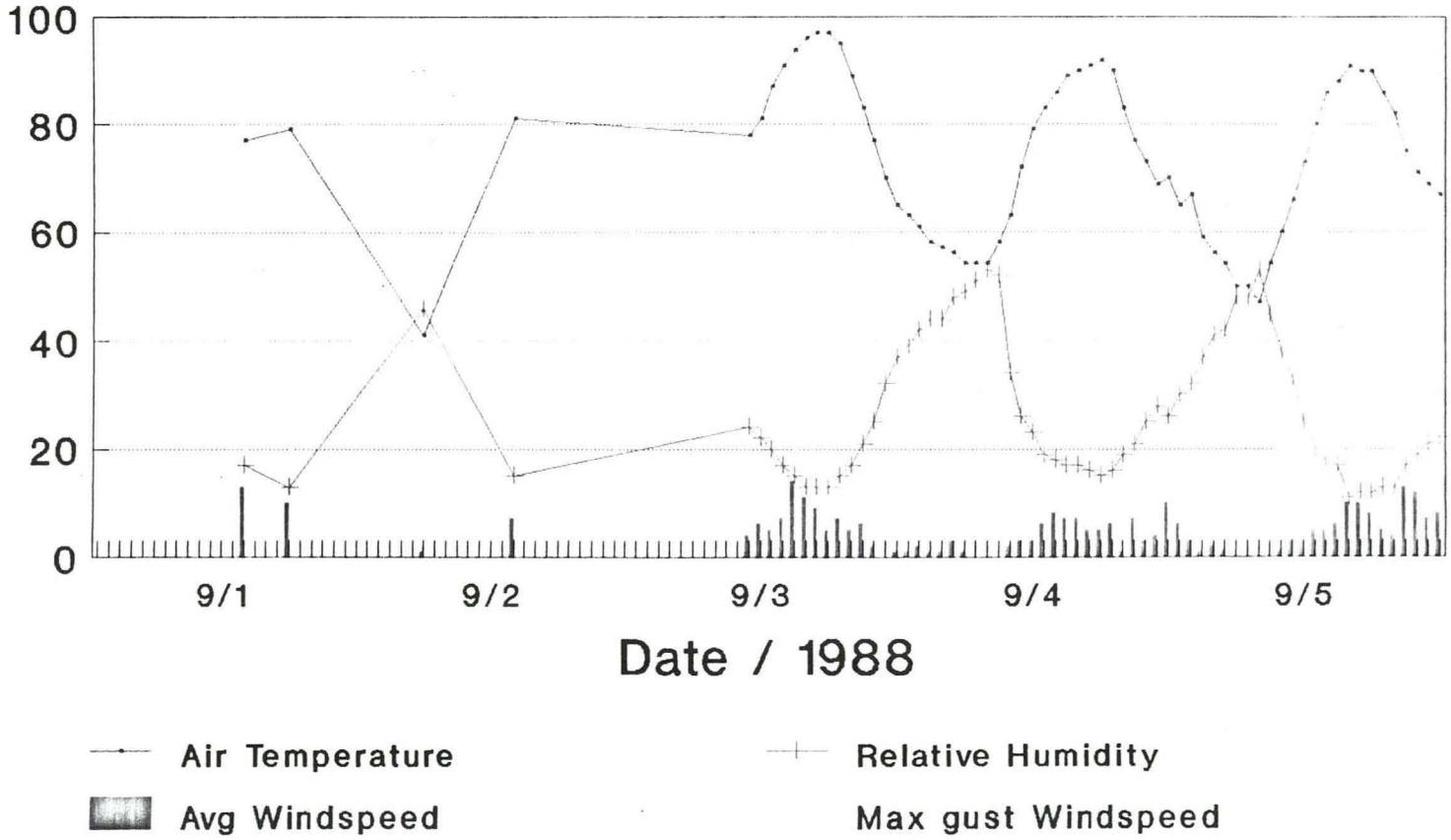


Figure 84. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for September 1 - September 5, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)

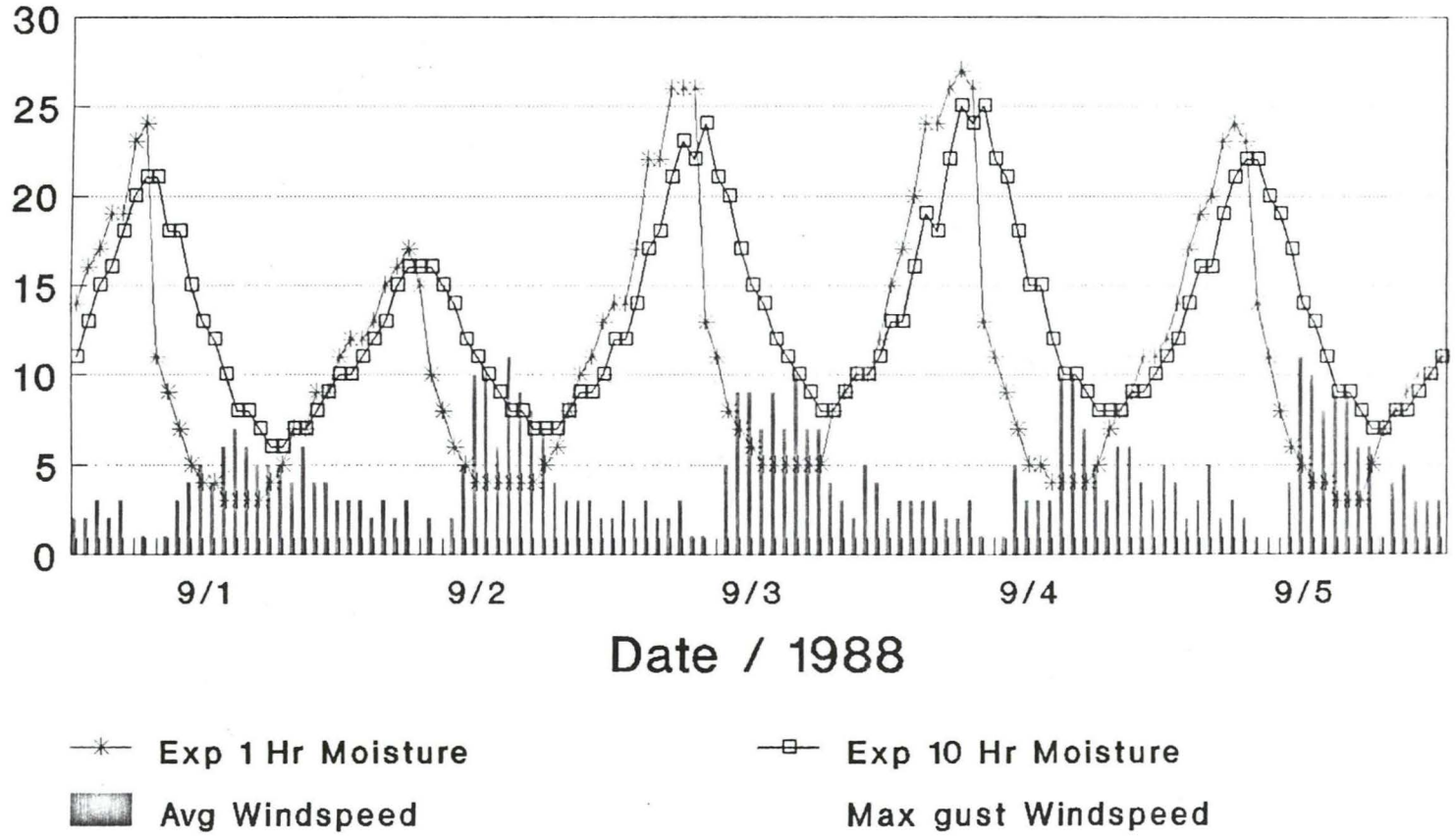
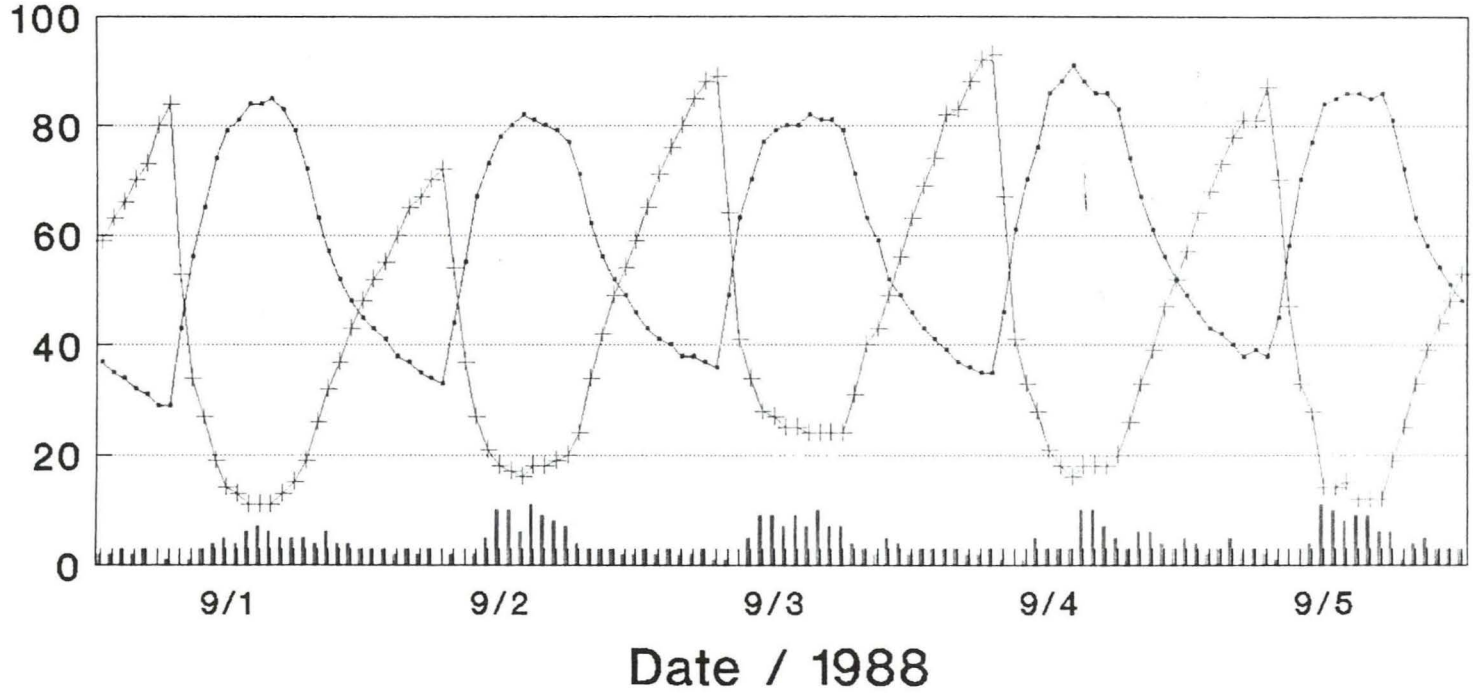


Figure 85. Benchmark RAWS Station air temperature, relative humidity, average wind speed, and maximum gust wind speed measurements for September 1 - September 5, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)



the river (USDA Northern Region, 1989). Extreme afternoon burning conditions on this side of the fire were DB 80-85F, RH 10-15%, winds southwest 6-12 MPH (Carlson, 1988). West Zone Probability of Ignition during the afternoon burning period was 60 - 70%.

No significant change in fire perimeter occurred on the East Zone of the fire. Fire continued to burn within the Lost Cabin Creek and Welcome Creek drainages as pockets of fuel missed during the fire runs of August 29th and 30th burned out. Probability of Ignition on the East Zone was the same during the afternoon as on the West Zone, 60 - 70%.

An additional 1,126 acres were added to the total fire perimeter on this date. Within perimeter fire acreage climbed to 55,466 acres.

1000 hrs. DB 73, WB 53, RH 29, wind southwest 2 MPH with gusts to 6. (Ridgetop in Lake Mountain Timber Sale area, 7200 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1115 hrs. DB 82, WB 58, RH 25, wind southwest 2-3 MPH. (Ridgetop in Lake Mountain Timber Sale area, 7200 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1200 hrs. "Activity on Canyon increasing two columns, one southwest edge, second northwest and east of the divide. Both dark gray-coppery colored (and) drift east / northeast. Winds west 5-10 MPH, 68 degrees." (Silver King Lookout radio log.)

1240 hrs. DB 81, WB 51, RH 11, wind southeast 2 MPH with gusts to 6. (Ridgetop in Lake Mountain Timber Sale area, 7200 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1342 hrs. "Lost Cabin (Creek) burning alot, 3/4+ (miles) from Welcome Creek hasn't crossed over the ridge yet." (Transmission from Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1400 hrs. "Two columns on Canyon Fire, one east of divide, second southwest edge." (Silver King Lookout radio log.)

1405 hrs. "Wind south 10-12 MPH. Visibility poor in valleys." (Silver King Lookout radio log.)

1414 hrs. "Head of Welcome Creek really blowing up." (Transmission from Welcome Creek Guard Station to the Augusta Information Station, radio log.)

1420 hrs. "Two smokes, one right along cat line on fire side, second past road just before rocks but still on the fire side." (Aerial observer to the Augusta Information Station, radio log.)

1425 hrs. "Burning more in Cave Creek; has crossed the Dearborn in Scapegoat Mountain burning mostly in bottom on south side of Lost Cabin Creek." (Transmission from G. Curtis to the Augusta Information Station, radio log.)

1500 hrs. DB 85, WB 54, RH 13, wind southeast 2-4 MPH with gusts to 8. (Ridgetop in Lake Mountain Timber Sale area, 7200 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1600 hrs. DB 86, WB 56, RH 16, wind south 2-4 MPH with gusts to 6. (Ridgetop in Lake Mountain Timber Sale area, 7200 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1700 hrs. DB 78, WB 54, RH 22, wind southeast 2 MPH with gusts to 6. (Ridgetop in Lake Mountain Timber Sale area, 7200 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1800 hrs. "Visibility poor." (Silver King Lookout radio log.)

Weather Forecast: Strong very dry high pressure aloft centered in eastern Washington and moving very slowly eastward during the next two days.

Weather for...Today
Weather...clear
Temperature...Max 85 at 6000 ft...68 at 8300 ft
Humidity...min 10%
Wind..eye level..less than 5 MPH at 6000 ft...north 5 to 10 MPH at 8300 ft
Weather for...Tonight
Weather...clear
Temperature...min 35 at 6000 ft..45 at 8300 ft
Humidity...max 55% at 6000 ft..35% at 8300 ft
Wind..eye level..less than 5 MPH at 6000 ft..north 5 MPH at 8300 ft
Outlook for Saturday and Sunday...little change

(National Weather Service Great Falls Office Spot Fire Weather Forecast for Canyon Fire, Lake Division, 0115 hrs. Thursday September 1, 1988)

Regional Weather: Morning low temperatures ranged from 33 degrees at West Yellowstone to 54 at Billings. A ridge of high pressure continued to build in the Intermountain West with its axis along the west coast and brought warm, dry, stable air with light winds to the Northern Region. A thermal low pressure area was developing over California and Oregon. Surface high pressure was also building over eastern Montana. These factors contributed to establish an easterly airflow over western Montana (Goens, 1990). Strong subsidence inversion conditions were developing across the Region and were expected to worsen as the high pressure ridge drifted east of the area. The layer of dry air that was drying fuel and causing increased nighttime fire activity dropped during the night to between 4,000 - 6,000 ft. Smoke from forest fires reduced visibility in the West Yellowstone area during the morning to less than 1/2 mile, most inversions broke in the late morning and skies cleared over these areas in the afternoon. Some Yellowstone areas remained smoked in all day. Several other locations also reported very smokey skies. Afternoon temperatures were mostly in the 80's across Montana. The highest temperatures reported in Montana were 98 degrees at Thompson Falls. High temperatures in the Yellowstone area ranged from the mid-70's to mid-80's with low afternoon humidities ranging from 9 to 15%. Washington had some unseasonably hot weather with the Quillayute area reporting temperatures in the low 90's. Clear skies prevailed over Idaho with temperatures mostly in the 80's and 90's (Bushey, 1989).

Long Range Weather Forecast: The three to five day outlook was for dry and unseasonably warm weather with light winds and low humidity. The six to ten day outlook called for temperatures much above normal and little or no precipitation. Normal high temperatures for this period are in the 70's.

The long range 30 day outlook for the month of September projected temperatures near or slightly above normal and precipitation to be below normal over the Region. The 90 day outlook for September through November indicated below normal temperatures across the Region except for normal temperatures in southwestern Montana. Precipitation during the 90 day period was expected to have a better probability of being greater than normal in northern Idaho and southwestern Montana than elsewhere in the Region where moisture was expected to be slightly greater than normal (Bushey, 1989).

SEPTEMBER 2 (Julian Date 246)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 70.0
Seeley Lake Ranger Station; 3-day running mean ERC: 43.3
Gleason's Resort; 3-day running mean ERC: 60.5

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.3%
Gleason's Resort; 3-day running mean 10 Hr: 4.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 11-9%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 17-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 16-7%

BEHAVE Fuel Moisture:

(West Zone)
24 hr High-Low range, 1 Hr fuel: 10-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 11-4% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%

(East Zone)
24 hr High-Low range, 1 Hr fuel: 13-4% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 16-4% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%

RAWS Fire Weather: Monture 24 hr temperature range: 41-81F
Monture 24 hr relative humidity range: 15-46%
Monture 24 hr average 20 ft wind speed range (MPH): no data
(Monture 1500 hrs readings; 81F, 15%)
Benchmark 24 hr temperature range: 33-82F
Benchmark 24 hr relative humidity range: 16-72%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-11
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):2-18
(Benchmark 1346 hr readings; 81F, 18%, 11 MPH gusts to 18)

West Zone Fire Behavior: The fire in the vicinity of Mineral Mountain had now backed all the way down into the bottom of Mineral Creek and has been a very predictable and steady backing fire moving down slope during the past week (Bonney, 1988).

In the vicinity of North Fork Trail, Madison Creek and Upper Lake Creek the fire slopped over the control line on the west side of Madison Creek during the night as a result of a combination of evening downslope winds (caused by the dropping of the subsidence inversion) and residual heat from an attempted burnout the previous day. Burnout was accomplished to within .25 mile of the packbridge with no problems encountered. Afternoon peak burning conditions experienced the following range of weather conditions; DB 75-85F, RH 12-18%, winds southwest 5-10 MPH, turning northeast to east at 1700 hrs (Carlson, 1988). At approximately 1900 hrs the fire became very active in the upper portion of the drainage just west of Madison Creek, and in the lower part of the East Fork of Lake Creek drainage. By 2000 hrs a major run pushed by emerging, strong east winds, was in progress crossing Lake Creek just below the East Fork of Lake Creek and moving up East Spread Mountain. The fire had completed its run by 2400. Fire behavior was extreme with 200' to 300' flame heights observed. ROS averaged 40 ch/hr (Carlson, 1988). During the east winds, activity picked up on all fire fronts, however the fire did not cross over to the east side of the North Fork of the Blackfoot River. Fire at Lake Mountain also became very active and threatened the fire management boundary. Probability of Ignition during the peak afternoon burning period in this zone was 60% at the higher elevations and 70% down in the drainage bottoms.

East Zone Fire Behavior: On the east side Curtis and a 20 man crew worked the Dearborn, keeping the main fire from making additional runs from the wilderness. Crews burned out on the west side of the river, south of Welcome Creek Guard Station. They also worked spots out of Pass Creek. Outside the wilderness, crews completed direct line along the north flank of the fire. The most active portion of the fire was along the northwest side. Probability of Ignition at the lower elevations of the fire on the East Zone rose to 70 - 80% during the afternoon peak burning period, and to 70% at the higher elevations where the fire was burning.

The fire was estimated at the time to be about 54,820 acres (USDA Northern Region, 1989). Later digitial mapping showed 533 acres burned on this date bringing the within perimeter fire acreage to 55,998 acres.

0700 hrs. "Winds east 6-8 MPH, clear. Low activity on fires, some spotty blanket smoke not much in valleys." (Silver King Lookout radio log.)

1130 hrs. "Inversion broke at 1130 hrs." (Ridgetop in Lake Mountain Timber Sale area, 7200 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1200 hrs. DB 73, WB 49, RH 16, wind south 0-2 MPH with gusts to 4. (Ridgetop in Lake Mountain Timber Sale area, 7200 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1225 hrs. "Ready to begin burnout on Division A. Will burn 1/2 mile line. Virtol stand ready in case it gets away." (General Message to Gauger, Incident Commander; from Hughes)

1300 hrs. DB 77, WB 52, RH 17, wind south 3-4 MPH with gusts to 8. "Smoke from east clouds the sun." (Ridgetop in Lake Mountain Timber Sale area, 7200 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1430 hrs. DB 74, WB 49, RH 16, wind south / southeast 0-2 MPH with gusts to 4. "Smokey sun, crowning, blow-up on top of ridge." (Ridgetop in Lake Mountain Timber Sale area, 7200 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1620 hrs. "Lines are looking good. Blacking a lot of line. Lines holding out good. Division B looks good." (Gauger to Canyon Creek Base Camp)

1700 hrs. DB 77, WB 52, RH 17, wind south 4-5 MPH with gusts to 10. "Smoke came down canyon can't see fire." (Ridgetop in Lake Mountain Timber Sale area, 7200 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

2325 hrs. "Heavy smoke drifting in and settling in canyons. Smoke very thick. Appears to be smoke from Canyon Fire." (Lolo National Forest Fire Dispatch radio log.)

Weather Forecast: Hot and very dry high pressure will continue over area next 2-3 days at least. Light wind pattern. Very low humidity.

Weather for the first burn period...this afternoon
Weather...mostly clear
CWR...zero
Temperature...88 at 5000 ft...80 at 6500 and 70s on top
Humidity...10 to 20%
Wind..eye level..slope type 0 to 5, northeast to southeast 5 to 15 ridges and through some passes.

Weather for second burning period...tonight
Weather...mostly clear
CWR...zero
Temperature...good cooling bottoms, fair slopes. Min 40's with 50's upper slopes
Humidity...from 60% bottoms to 35 to 45% slopes/ridges
Wind..eye level..light slope type, southeast to east 5 to 10 ridges

Outlook for Saturday...little change indicated at this time

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, Elk Creek Division, 0900 hrs. Friday September 2, 1988)

Regional Weather: A very strong ridge of high pressure aloft continued to build over the Pacific Northwest and the Northern Rocky Mountains. The ridge extended far to the north over western Canada. The general east wind pattern established the previous day persisted. The high pressure ridge was also helping to cause the subsidence inversion to drop in elevation over the entire Region. At 0600 hrs the inversion was at 3,500 ft in Spokane and at 4,000 ft in Great Falls. This inversion contributed to extensive thermal belt conditions, and poor fuel moisture recovery during the night. Strong, downslope east winds on the west side of the Continental Divide were also created as the subsidence inversion dropped in the evenings, causing hot, dry winds lasting from about 1700 hrs to as long as 2000 hrs in some areas. These conditions caused extreme burning conditions to last the entire night. Skies were generally clear over the Region during the night, altho a few areas had some smoke. Overnight low temperatures up to 0600 hrs ranged from 35 degrees at West Yellowstone, and 39 degrees at both Butte and Bozeman up to 56 at Billings. Hot, dry conditions were the rule across the Region during the day with several high temperature records set. Missoula equaled its record of 95 previously established in 1950, Kalispell set a new record at 93. Medford and

Portland, Oregon as well as Olympia and Seattle in Washington established new record highs for the month of September. 110 degrees at Medford was the highest from that group of stations. Thompson Falls with 103 was the warmest location in Montana (Bushey, 1989).

SEPTEMBER 3 (Julian Date 247)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 71.0
Seeley Lake Ranger Station; 3-day running mean ERC: 42.6
Gleason's Resort; 3-day running mean ERC: 61.0

The Lincoln Ranger Station reached its highest ERC level for the 1988 season and is within 1 point of equalling the 100th percentile level for the 1973-1987 seasons.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.6%
Gleason's Resort; 3-day running mean 10 Hr: 4.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: no data-2%
Monture, 24 hr High-Low range, 10 Hr fuel: no data-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 26-5%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 24-8%

BEHAVE Fuel Moisture:

(West Zone)
24 hr High-Low range, 1 Hr fuel: 8-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 9-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

(East Zone)
24 hr High-Low range, 1 Hr fuel: 12-4% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%
24 hr High-Low range, 1 Hr fuel: 14-5% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

RAWS Fire Weather: Monture 24 hr temperature range: 70-97F
Monture 24 hr relative humidity range: 13-32%
Monture 24 hr average 20 ft wind speed range (MPH): 0-14
Monture 24 hr range of maximum wind gusts (MPH): 3-23
(Monture 1400 hrs readings; 87F, 20%, 5 MPH)
Benchmark 24 hr temperature range: 36-82F
Benchmark 24 hr relative humidity range: 24-89%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-10
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):3-22
(Benchmark 1346 hr readings; 82F, 24%, 7 MPH gusts to 19)
(figure 86)

West Zone Fire Behavior: East winds again hit the this zone during the afternoon and the fire becomes very active. Fire in the bottom of Mineral Creek exhibited active torching and crowning near the mouth of the East Fork of

Mineral Creek and Mineral Creek. The fire moved up Mineral Creek about 1/2 - 3/4 mile and was spotting 1/4 mile ahead. The possibility existed that the fire would possibly move up to Windy Pass within the next 24 hrs (Bonney, 1988).

After an evening of pretty active fire behavior, the fire in the area of the North Fork Packbridge remained fairly static with some activity north of the West Fork of Lake Creek during the day. During the morning ash fall was found on equipment at the Monture Guard Station from the previous night's fire activity. The fire in Lake Creek was positioned for a major run with any westerly air movement. The burnout above the packbridge was accomplished successfully aided by the northeast airflow. Line was completed to the bottom of Lake Creek, west of Madison Creek. Fire weather during the afternoon in the vicinity of Lake Creek ranged from DB 80-85F, RH 15-25%, winds east to southeast 8-12 MPH (Carlson, 1988). Probability of Ignition during these peak burning conditions again ranged from 60 - 70%.

East Zone Fire Behavior: On the east side, the fire remained relatively calm for the third day in a row. Crews constructed handline and explosive fireline along the northwest side of the fire from the head of Smith Creek to Welcome Pass (USDA Northern Region, 1989). Probability of Ignition on the East Zone also ranged from 60 - 70% during the afternoon peak burning conditions over the elevational ranhe of the fire.

Newly burned acreage on this date was similar to the previous day's burned area; 504 acres. Within perimeter fire acreage increased to 56,502 acres.

0001 hrs. "Fires burned 3/4 way down talus, run across Lake Creek, now 4-5 miles with pretty good glow. Winds northwest still strong." (Canyon Creek Fire Base, Lake Mountain Division, radio log.)

0415 hrs. "Very little fire and no wind." (Canyon Creek Fire Base, Lake Mountain Division, radio log.)

0955 hrs. "Slop over in Division A. Too much smoke to determine fire activity." (Canyon Creek Fire Base, Lake Mountain Division, radio log.)

1000 hrs. DB 65, WB 50, RH 38, wind north-northeast 1-3 MPH with gusts to 8. (Ridgetop in Lake Mountain Timber Sale area, 6700 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1035 hrs. "Slop over at H-2." (Canyon Creek Fire Base, Lake Mountain Division, radio log.)

1147 hrs. "Winds south 10-12 MPH." (Silver King Lookout radio log.)

1203 hrs. "Column Mineral Creek, large, black-gray." (Silver King Lookout radio log.)

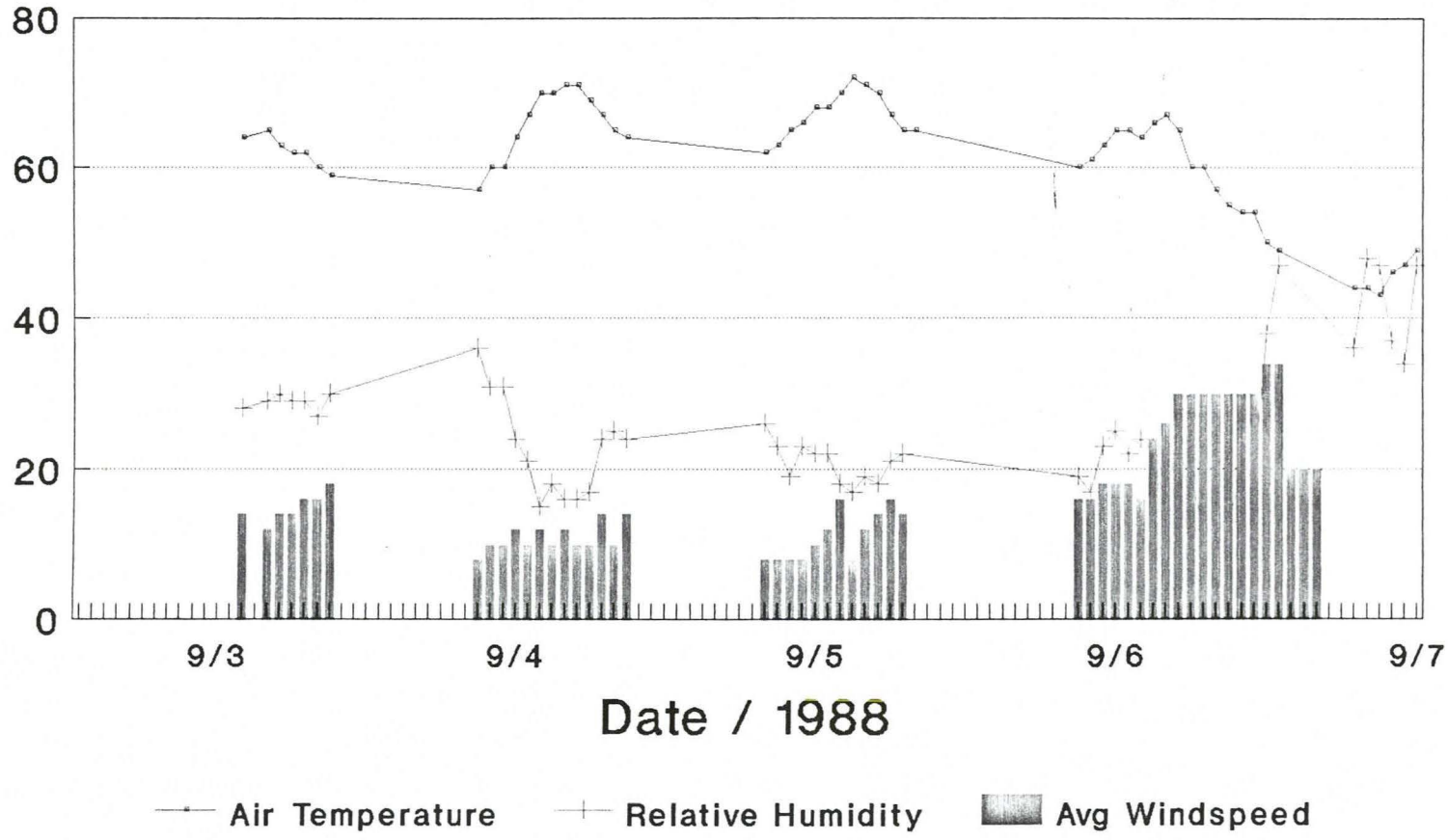
1330 hrs. DB 80, WB 55, RH 22, wind east 2-4 MPH with gusts to 10. (Ridgetop in Lake Mountain Timber Sale area, 6400 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1400 hrs. "Large column smoke, black-gray, 1200-1400' elevation." (Silver King Lookout radio log.)

Figure 86. Silver King Lookout Station air temperature, relative humidity, and average wind speed measurements for September 3 - September 7, 1988.

Fire Weather

Silver King Mountain Lookout (241905)



Belt Weather Kit Observations

1400 hrs. DB 64, RH 28, wind 14 from the south - southwest - east - southeast (Silver King Lookout Weather log.)

1530 hrs. DB 75, WB 53, RH 25, wind northeast 3-5 MPH. "Smoke covered the sun, really cooled." (Ridgetop in Lake Mountain Timber Sale area, 6400 ft elevation, Fire Weather Observer notes, Lake Mountain Division.)

1600 hrs. DB 65, RH 29, wind 12 from the north (Silver King Lookout Weather log.)

1615 hrs. "Columns coming off of Canyon, Elk Division, T16N, R6W Section 9." (Silver King Lookout radio log.)

1700 hrs. DB 76, WB 53, RH 28, wind southeast 0-2 MPH with gusts to 8. "Smoke about covering everything." (Ridgetop in Lake Mountain Timber Sale area, 6400 ft elevation, Fire Weather Observer notes, Lake Division.)

1700 hrs. DB 63, RH 30, wind 14 from the southeast (Silver King Lookout Weather log.)

1705 hrs. "Completed burnout." (Canyon Creek Fire Base, Lake Mountain Division, radio log.)

1800 hrs. Burning-out south of the Dearborn River, 1/4 mile W of the Welcome Creek Cabin (USDA Northern Region, 1989).

1800 hrs. DB 62, RH 29, wind 14 from the west (Silver King Lookout Weather log.)

1815 hrs. DB 77, WB 57, RH 26%, surface winds northeast 4-7 MPH, winds aloft east; aspect south, upper 1/3 slope, 5800 ft msl elevation, medium tree cover. (Fire Weather Observer, West Zone.)

1900 hrs. DB 62, RH 29, wind 16 from the north (Silver King Lookout Weather log.)

2000 hrs. DB 60, RH 27, wind 16 from the northwest - west (Silver King Lookout Weather log.)

2100 hrs. DB 59, RH 30, wind 18 from the northeast (Silver King Lookout Weather log.)

2312 hrs. "Ovando; smoke low to ground and light." (Lolo National Forest Fire Dispatch radio log.)

2326 hrs. "Clearwater Junction; smoke light, can smell it." (Lolo National Forest Fire Dispatch radio log.)

2355 hrs. "At Seeley Lake; smokey, light ash fall, strong smell. Smoke drift from Seeley Lake toward Arlee." (Lolo National Forest Fire Dispatch radio log.)

Weather Forecast: High pressure will hold through the weekend over the region with little change in the weather.

Weather for the first burn period...this afternoon
Weather...sunny
CWR...zero
Temperature...afternoon highs 75 to 85
Humidity...still quite dry, afternoon lows 13-20%
Wind..eye level..mainly upslope 3-8 MPH, southerly across high ridges 5-10 MPH.

Weather for second burning period...tonight
Weather...fair and smokey
CWR...zero
Temperature...cool in the major bottom areas, lows near 40. Midslope and above, low 45-55 or warmer possible.
Humidity...near 60% bottom areas, poor recovery midslope and above, likely only near 35%
Wind..eye level..mainly downslope 0-4 MPH, still southerly across the ridges 5-8 MPH

Outlook for Sunday...very little change from today

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, Elk Creek Division, 1040 hrs. Saturday September 3, 1988)

Weather Forecast: Strong high pressure will be in place for little change to our weather pattern through Monday. Tuesday and Wednesday will see a frontal passage and windy conditions. Any nighttime inversions less deep than last night.

Weather for the first burn period...this evening and tonight
Weather...clear. Smoke settling into low spots around sunset
CWR...zero
Temperature...cool in the bottom areas, lows 35-40. Midslope and above will be quite warm, lows 45-55 or warmer
Humidity...Max 70 to 80% coldest bottom areas, poor recovery midslope and above only near 45%
Wind..eye level..east across ridges 3-8 MPH, otherwise mainly downslope 0-1 MPH

Weather for second burning period...Sunday
Weather...sunny, morning inversion breaking up early
CWR...zero
Temperature...warm again, highs 80-85 with smoke shading the fire, warmer if not
Humidity...dry again, lows mainly 15-25%
Wind..eye level..upslope for the most part, 4-8 MPH, easterly across ridges 8-12 MPH, east slopes will have higher speed to 12 MPH or so

Outlook for Monday...Sunny and a few degrees cooler, otherwise little change

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, 1900 hrs. Saturday September 3, 1988)

Regional Weather: The high pressure ridge had gotten stronger and was nearly stationary, centered over the Idaho panhandle. Also at the surface; high pressure in southern Canada and east of the divide, and low pressure over Washington and Oregon continued to create an easterly pressure gradient with local northeast to southeast winds in western Montana. Livingston and Missoula had 15 to 25 MPH east winds, while the rest of the state had mostly 5 to 15 MPH winds. These winds brought in a heavy smoke layer into the Missoula area

valleys from the Canyon Creek Fire in the Scapegoat Wilderness northeast of the city. During the night skies were generally clear around Montana, except for layers of smoke in areas of western Montana. Overnight low temperatures as of 0600 hrs ranged from 39 degrees at smokey West Yellowstone to 56 at Billings. Hottest temperatures during the day, as the day before, were in the valleys of western Montana and northern Idaho where they reached into the 90's. Missoula set a new high temperature mark for the date with 98 degrees, previous high was recorded in 1967 (another severe fire season) and equaled the day before. Kalispell established another record high temperature of 97 for the date. Montana's high temperature for the day was at Thompson Falls with 99 degrees. The rest of the Region was influenced by the surface high pressure over Canada and had cooler temperatures in the 80's. Out of Region numerous records high temperatures were also being reached. In northern California the mercury rose to a blistering 116 at Redding and 117 at Red Bluff. Washington state continued to experience unseasonably hot temperatures again on this date with Moses Lake reporting 109 degrees, and 106 at Ephrata. Medford, Oregon reached 107 degrees. The coast was considerably cooler, barely getting out of the 50's. Dense smoke in portions of Idaho kept temperatures cooler in those areas, the rest of the state was in the 90's with Moscow hitting 106 (Bushey, 1989).

Long Range Weather Forecast: The three to five day outlook was for continued warm and sunny days that would be a little cooler than previous days. The six to ten day outlook indicated near normal temperatures west of the Continental Divide and above normal temperatures to the east. Normal high temperatures for this time period are in the 70's. No precipitation or below normal precipitation was expected across the Region (Bushey, 1989).

Miscellaneous: The Palmer Drought Severity Index illustrated most of northern Idaho under moderate drought conditions. An area extending through northcentral Idaho and into the western edge of Montana had become severely impacted by the drought. A small area of moist soil conditions still remained in northern Idaho, but was being continually reduced in extent with each new set of published indices. The rest of the Region was under extreme drought conditions (Bushey, 1989).

SEPTEMBER 4 (Julian Date 248)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 70.0
Seeley Lake Ranger Station; 3-day running mean ERC: 42.6
Gleason's Resort; 3-day running mean ERC: 59.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.3%
Gleason's Resort; 3-day running mean 10 Hr: 5.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 11-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 19-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 25-8%

BEHAVE Fuel Moisture:

(West Zone) 24 hr High-Low range, 1 Hr fuel: 11-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%
24 hr High-Low range, 1 Hr fuel: 12-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

(East Zone) 24 hr High-Low range, 1 Hr fuel: 15-6% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6%
24 hr High-Low range, 1 Hr fuel: 20-6% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 7-6%

RAWS Fire Weather: Monture 24 hr temperature range: 54-92F
Monture 24 hr relative humidity range: 15-53%
Monture 24 hr average 20 ft wind speed range (MPH): 0-8
Monture 24 hr range of maximum wind gusts (MPH): 2-16
(Monture 1400 hrs readings; 83F, 19%, 6 MPH)
Benchmark 24 hr temperature range: 35-91F
Benchmark 24 hr relative humidity range: 18-93%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-10
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):3-22
(Benchmark 1346 hr readings; 88F, 18%, 10 MPH gusts to 22)

West Zone Fire Behavior: In the area of Lake Creek the burnout produced the most active fire behavior of the day. Favorable winds pushed the fire to the interior as the burnout progressed up Lake Creek. The rate of firing was slow because of the fire intensity. No escapes were experienced in this area with handlines in Madison Creek and on the west side of the North Fork of the Blackfoot holding (Carlson, 1988). Further west the fire spotted south across Lake Creek and on to the east side of East Spread Mountain, caused by a strong east wind. The range of extreme burning conditions experienced in the vicinity of Lake Creek during the afternoon were; DB 75-80F, RH 12 -18%, winds east to southeast 8-12 MPH (Carlson, 1988). Probability of Ignition within this zone again ranged between 60 - 70% during the afternoon burning period. The fire was still about 1 mile north of the Fire Management line. Approximately 7,450 acres extended outside of the Lolo's portion of the Scapegoat Wilderness.

East Zone Fire Behavior: On the east zone, crews continued to build fireline between Smith Creek and Welcome Pass. The northeast side of the fire was cool and crews mopped-up. Crews burned-out south of Elk Creek road, but not into Cataract Creek. In the wilderness crews burned-out along the south side of the Dearborn river to prevent the fire from advancing further north into Welcome Creek (USDA Northern Region, 1989). East Zone probability of Ignition only rose to 50% during the afternoon because of increased relative humidities.

This day's fire activity increased the burned area by 1,966 acres. This brought the within perimeter fire acreage total to 58,468 acres.

1715 hrs. "DB 85, WB 78, RH 18%, wind east 3-4 MPH; aspect southeast, 4800 ft msl elevation, Bottom 1/3 of medium timbered slope." (Canyon Creek Fire Base, Lake Mountain Division, radio log.)

0900 hrs. DB 57, RH 36 wind 8 from the south (Silver King Lookout Weather log.)

1000 hrs. DB 60, RH 31, wind 10 from the southwest (Silver King Lookout Weather log.)

1100 hrs. DB 60, RH 31, wind 10 from the south (Silver King Lookout Weather log.)

1200 hrs. DB 64, RH 24, wind 12 from the south (Silver King Lookout Weather log.)

1300 hrs. DB 67, RH 21, wind 10 from the south - southwest (Silver King Lookout Weather log.)

1400 hrs. DB 70, RH 15, wind 12 from the south (Silver King Lookout Weather log.)

1500 hrs. DB 70, RH 18, wind 10 from the southeast (Silver King Lookout Weather log.)

1600 hrs. DB 71, RH 16, wind 12 from the east (Silver King Lookout Weather log.)

1700 hrs. DB 71, RH 16, wind 10 from the north (Silver King Lookout Weather log.)

1800 hrs. DB 69, RH 17, wind 10 from the north (Silver King Lookout Weather log.)

1900 hrs. DB 67, RH 24, wind 14 from the northeast (Silver King Lookout Weather log.)

2000 hrs. DB 65, RH 25 wind 10 from the north (Silver King Lookout Weather log.)

2100 hrs. DB 64, RH 24, wind 14 from the north - northwest (Silver King Lookout Weather log.)

Weather Forecast: For tonight high pressure will hold over the region, but Monday will begin to see the changes expected by an approaching off shore weather system. the first noticeable change will be a switch in wind direction late Monday afternoon.

Weather for the first burn period...this afternoon
Weather...smokey but no clouds
CWR...zero
Temperature...still quite warm, highs 85-90
Humidity...dry, 15-25%
Wind..eye level..east to northeast 4-8 MPH, 5-12 MPH late afternoon

Weather for second burning period...tonight
Weather...smokey but no clouds
CWR...zero
Temperature...lows generally 45-55, cooler in bottom areas
Humidity...recovery fair at best, max 40-55% mainly, better in bottoms

Wind..eye level..easterly this evening, 10-15 MPH. Decreasing around midnight to be easterly 2-7 MPH.

Outlook for Monday

Weather...smokey, but generally noclouds

CWR...zero

Temperature...cooler. Afternoon maxs 80-85

Humidities...still quite dry, mins 17-25%

Wind..eye level..easterly during the day, 5-10 MPH, but late afternoon beginning to switch around to the south

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, 1300 hrs. Sunday September 4, 1988)

Weather Forecast: Strong high pressure will hold tonight, but Monday changes in the pattern will occur when an offshore weather system moves east. A red flag watch is in effect for Monday for changing wind directions and Tuesday for a dry cold frontal passage with strong winds.

Weather for this evening and tonight...

Weather...clear, smoke settling into the low spots around sunset

CWR...zero

Temperature...mins generally 45-55 with bottom areas cooler

Humidity...recovery mainly poor, max 45-55% mainly with bottom areas higher

Wind..eye level..easterly across the ridges 3-8 MPH, otherwise mainly downslope 0-4 MPH

Weather for Monday...

Weather...mostly sunny. Inversions breaking up about 1030.

CWR...zero

Temperature...warm again, highs 85-90 mainly

Humidity...dry again, lows mainly 15-20%

Wind..eye level..upslope for the most part, 4-8 MPH, easterly across ridges 8-12 MPH, but becoming more southerly in late afternoon

Outlook for Tuesday...High clouds, dry cold frontal passage sometime in the afternoon. Winds becoming strong and westerly. temperatures about 10 degrees cooler and humidity up about 5% or more.

(Missoula Fire Weather Office Spot Fire Weather Forecast for Canyon Fire, 1810 hrs. Sunday September 4, 1988)

Regional Weather: The strong high pressure ridge remained fixed in position over the Northern Region. The surface high previously over eastern Montana moved east over the Dakotas lessening the pressure gradient, winds were generally light and slope induced (Goens, 1990). Strong subsidence inversionconditions existed across the entire Region, at the surface in Boise and Spokane and at 8,500 ft in Great Falls. This inversion caused poor nighttime fuel moisture recovery in most areas. Overnight skies were clear over most of Montana except for areas of smoke. Low temperatures as of 0600 hrs ranged from 38 degrees at smokey West Yellowstone to 58 at Glasgow. Visibility was restricted to 1/8 of a mile during the morning at West Yellowstone. Missoula was under approximately 95% cover of smoke at an elevation starting at 5,000 ft. Afternoon temperatures were slightly cooler than the previous days, but not by much. Temperatures were still 10 to 20 degrees above normal for this time of the year. Missoula reached 94 degrees and was only 1 degree short of tying the previous record established in 1967. Thompson Falls reached 102, Superior attained 100 degrees. Lewiston, Idaho reached the century mark for the afternoon high temperature (Bushey, 1989).

SEPTEMBER 5 (Julian Date 249)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 69.5
Seeley Lake Ranger Station; 3-day running mean ERC: 43.0
Gleason's Resort; 3-day running mean ERC: 60.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 4.6%
Gleason's Resort; 3-day running mean 10 Hr: 4.5%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 18-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 24-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 22-7%

BEHAVE Fuel Moisture:

(West Zone)	24 hr High-Low range, 1 Hr fuel: 10-5% at 5600 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
	24 hr High-Low range, 1 Hr fuel: 11-5% at 7800 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
(East Zone)	24 hr High-Low range, 1 Hr fuel: 16-4% at 5200 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%
	24 hr High-Low range, 1 Hr fuel: 21-5% at 7200 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

RAWS Fire Weather: Monture 24 hr temperature range: 47-91F
Monture 24 hr relative humidity range: 11-53%
Monture 24 hr average 20 ft wind speed range (MPH): 0-13
Monture 24 hr range of maximum wind gusts (MPH): 2-21
(Monture 1400 hrs readings; 80F, 20%, 5 MPH)
Benchmark 24 hr temperature range: 38-86F
Benchmark 24 hr relative humidity range: 12-87%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-11
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):2-26
(Benchmark 1346 hr readings; 86F, 12%, 9 MPH gusts to 20)

West Zone Fire Behavior: Fire had moved up and over Windy Pass and was now on the west slope of Bugle Mountain exhibiting extreme fire behavior (Bonney, 1988).

Because of forecasted winds for tomorrow (Tuesday) a burnout from the West Fork of Lake Creek was scheduled for the afternoon (control lines for the burnout would not be in place until 1600 hrs). The fire weather forecaster warned that even through wind conditions would remain light they would become variable. The winds were at 4-8 MPH from the southeast through the morning. Burnout was to begin at 1600 hrs. At 1400 hrs fire activity picked up noticeably and at 1430 a spot developed behind the control line in the bottom of Lake Creek. At this time a shift in the wind from southeast to northwest occurred. Wind velocity was no more than 4-6 MPH. The spot at this time was about 1/2 acre and radient heat from the hillside to the east was igniting the

crowns of lodgepole pine ahead of the ground fire to the west. At the same time areas just up drainage became active and started moving toward escape. The convective activity reinforced the down drainage airflow and precipitated a major run down the bottom of Lake Creek. The run occurred in two distinct segments; the fire first moved down the creek bottom and hooked around the burnout line from the previous day and moved up into Madison Creek, another area of fire was just behind the first and moved along the south side of the Lake Creek bottom and up into the South Fork Timber Sale Area. Afternoon extreme burning conditions in the vicinity of Lake Creek were; DB 80-85F, RH 8-12%, winds southeast to south 4-8 MPH until 1600 hrs then northwest 4-8 (Carlson, 1988). Probability of Ignition during the afternoon burning period in this zone was 60%. By 1900 hrs the fire had moved as far east as the North Fork of the Blackfoot, and as far south as the ridgetop in Section 29. Also, one major spot was across the river in Section 27. After dark the majority of the activity was in the South Fork Timber Sale Area as the fire completed it's run to the ridgetops (Carlson, 1988).

East Zone Fire Behavior: At approximately 1300 hrs fire activity increased in the head of the Dearborn River and Red Slide Mountain as a section of fireline was crossed and the fire moved down drainage toward Welcome Creek. Other areas of fire active remained relatively calm. Peak afternoon burning conditions witnessed East Zone Probability of Ignition values of 70% at the lower elevations and 60% at higher locations. The declining afternoon relative humidity was contributing to the increase in Probability of Ignition over previous afternoons in this zone.

By the end of the day the fire was estimated to be 57,180 acres (USDA Northern Region, 1989). Later digitized mapping showed 9,524 acres burned on this date bringing the within perimeter fire acreage to 67993 acres.

0700 hrs. "Visibility 1/2 mile." (Canyon Creek Fire, Lake Mountain Division radio log, transmission from Helibase.)

0800 hrs. DB 62, RH 26, wind 8 from the west (Silver King Lookout Weather log.)

0900 hrs. DB 63, RH 23, wind 8 from the west - northwest (Silver King Lookout Weather log.)

1000 hrs. DB 65, RH 19, wind 8 from the west (Silver King Lookout Weather log.)

1057 hrs. "Shut down inbound due to visibility." (Canyon Creek Fire, Lake Mountain Division Helibase log.)

1100 hrs. DB 66, RH 23, wind 8 from the northwest (Silver King Lookout Weather log.)

1140 hrs. "Helibase is down due to poor visibility." (General Message from Helibase to Incident Commander Canyon Creek Fire, Lake Mountain Division)

1200 hrs. DB 68, RH 22, wind 10 from the west (Silver King Lookout Weather log.)

1208 hrs. "Visibility is terrible." (Canyon Creek Fire, Lake Mountain Division Helibase log.)

1300 hrs. DB 68, RH 22, wind 12 from the west - northwest (Silver King Lookout Weather log.)

1309 hrs. "Lost major section of line, headed up canyon toward Straight Creek." (Transmission from Redmond Hot Shot's to the Augusta Information Station, radio log.)

1313 hrs. "800 yards across top line, pulling back; (fire) moving down the valley towards Welcome Creek, moving from west to east." (Transmission from Redmond Hot Shot's to the Augusta Information Station, radio log.)

1320 hrs. "Pulling (back) to the Dearborn." (Transmission from Redmond Hot Shot's to the Augusta Information Station, radio log.)

1400 hrs. DB 70, RH 18, wind 16 from the west - northwest - north (Silver King Lookout Weather log.)

1426 hrs. "Jumped line between Spike (Camp) 1 and H-2." (Canyon Creek Fire, Lake Mountain Division Helibase log.)

1431 hrs. "Spread to the east, retardant may not do any good now, reaccess for us. Smoke may be to thick for recon. Two miles west of cabin." (Airtack II to Redmond Hot Shot's; Augusta Information Station, radio log.)

1440 hrs. "There has been a slope over in Division B close to Spike (Camp) 2 and Carlson (FBA) recommends to get the crew in the black ASAP. It could make a major run down Lake Creek." (Canyon Creek Fire, Lake Mountain Division radio log, transmission from Division B to Division A)

1450 hrs. "Divisions A and B in black when fire blew. Weather observations at that time were DB 85, WB 54, RH 10%. (General Message from Operations to Incident Commander Canyon Creek Fire, Lake Mountain Division)

1500 hrs. DB 72, RH 17, wind 8 from the south - west (Silver King Lookout Weather log.)

1600 hrs. DB 71, RH 19, wind 12 from the north (Silver King Lookout Weather log.)

1600 hrs. "Everybody off fire to the DPS at the trailhead." (Canyon Creek Fire, Lake Mountain Division radio log.)

1630 hrs. The fire jumped the fireline and spread south and east. It was from the burnout that had occurred the previous day.

1642 hrs. "Fire has gone down canyon into Timber Sale." (Canyon Creek Fire radio log.)

1645 hrs. "Blow-up." (Canyon Creek Fire, Lake Mountain Division Helibase log.)

1655 hrs. "All stations west of fire reporting 10% or below RH, 10 MPH winds." (General Message from Communications to Rich Lasko, FBA Canyon Creek Fire Lake Mountain Division)

1700 hrs. DB 70, RH 18, wind 14 from the north - northeast (Silver King Lookout Weather log.)

1725 hrs. "Winds are calming down." (Canyon Creek Fire, Lake Mountain Division, radio log.)

1740 hrs. "Can see fire, it's up to northwest of Section 27. Fire has moved to top of ridge. It's on east side of canyon, east side of DP's, east side of North Fork." (Canyon Creek Fire, Lake Mountain Division, radio log, transmission from ground observer)

1745 hrs. "Air attack reported that the fire hasn't crossed the river yet. About 3 or 4 miles before it hits the Cooper's Lake area." (Canyon Creek Fire, Lake Mountain Division, radio log.) [Note; the fire did not cross the river on this date.]

1748 hrs. "Reports wind moving south down canyon and (fire) is almost to DP-1." (General Message from ground observers to Canyon Creek Fire, Lake Mountain Division, Base - Plans)

1800 hrs. DB 67, RH 21, wind 16 from the east - northeast (Silver King Lookout Weather log.)

1800 hrs. "Fire is now 3-400 feet from the river. Air attack will drop on it." (Canyon Creek Fire, Lake Mountain Division, radio log.)

1800 hrs. The fire was spreading rapidly, pushed by strong winds from the west. It was moving into Lake Creek and east into the North Fork of the Blackfoot. The fire had reportedly spread south of Lake Creek into the South Lake Timber Sale Area.

1800 hrs. "Visibility 5 miles.." (Silver King radio log.)

1858 hrs. "Fire is burning straight down canyon and just before first bridge." (Canyon Creek Fire, Lake Mountain Division, radio log.)

1900 hrs. DB 65, RH 22, wind 14 from the north (Silver King Lookout Weather log.)

1900 hrs. Williams noted how strong the vent was in an inversion above the South Lake Timber Sale Area, south of Lake Creek. The fire was in a blow-up condition, and exhibiting extreme fire behavior. Smoke from as far away as Canyon Point (approximately 9 air miles to the north / northwest) was being pulled horizontally into the vent.

1917 hrs. "Fire has reached trailhead at parking lot and area is on fire." (General Message from ground observers to Canyon Creek Fire, Lake Mountain Division, Base - Plans.)

1919 hrs. "Fire running up slope on northwest of DP-3." (General Message from ground observers to Canyon Creek Fire, Lake Mountain Division, Base - Plans.)

2000 hrs. "Dead calm. No ash." (Silver King radio log.)

2000 hrs. DB 65, wind calm from the east (Silver King Lookout Weather log.)

2009 hrs. "Fire goes from DP-1 southwest up the ridge toward the clearcut and just hit the top of the ridge." (General Message from ground observers to Canyon Creek Fire, Lake Mountain Division, Base - Plans.)

2055 hrs. "Can't see anything now. Down by creek the fire has laid down. Bottom is real slow, but on top by the clearcuts it's really boiling." (General Message from ground observers to Canyon Creek Fire, Lake Mountain Division, Base - Operations.)

2245 hrs. A report came that there was a 3-5 acre spot on the east side of the North Fork of the Blackfoot River. Fire activity was extreme. Carlson measured 9% RH at Lake Creek.

2258 hrs. "DB 65, WB 45, RH 21%, winds south 0-2 MPH." (Canyon Creek Fire, Lake Mountain Division, radio log.)

2259 hrs. "At bottom of hill; DB 70, WB 52, winds 0-5 variable." (Canyon Creek Fire, Lake Mountain Division, radio log.)

Weather Forecast: The high pressure that has been over us is beginning to break down ahead of a couple of weather systems to the west, the first of which is moving into Canada now. Changing conditions will be the story beginning tonight as a dry cold front is expected to pass through Tuesday. A Red Flag Watch is in effect for tonight for a wind shift to the south and in effect for Tuesday for strong west winds with the front.

For This Afternoon and Tonight...
Weather...smokey but thinning a little
CWR...zero
Temperature...maxs generally 85-90, possibly cooler bottom areas under thicker smoke
Humidity...afternoon mins 20-25% under heavier smoke, near 15% ridges.
Wind..eye level..mainly easterly across ridges 3-8 MPH. Otherwise variable 2-6 MPH and terrain driven

For Tonight...
Weather...smokey again
CWR...zero
Temperature...mins generally 45-55, cooler in bottom areas
Humidity...recovery fair under smoke layer, near 70%, but about midslope and above recovery poor, max 35%
Wind..eye level..becoming southeast to south this evening and southwest by morning on ridges, 3-7 MPH. Otherwise calm to downslope winds 0-3 MPH.

Outlook for Tuesday...Dry cold front passage, timing about midday. temperatures 10-15 degrees cooler and humidity up about 10%. Winds becoming west 10-20 MPH across ridges. (Missoula Fire Weather Office Spot Fire Forecast for Canyon Creek Fire; Lake Creek Division, 1200 hrs., and the Elk Creek Division, 1300 hrs. Monday September 5, 1988)

Regional Weather: Skies were generally clear across Montana with layers of smoke aloft over portions of southern and western Montana. Generally light, variable winds during the night (less than 10 MPH) kept the smoke from being cleared from the valleys. West Yellowstone reported visibility was reduced to 1/16 of a mile, in Livingston visibility was reported as low as 1/4 mile at times. Temperatures at 0600 hrs ranged from 34 degrees at West Yellowstone to 58 at Billings. Most readings were in the low to mid-50's. During the morning the NWS issued Red Flag Watches for western Montana and northern Idaho for the up coming night and the 6th. These watches were for gusty winds, low humiditues, and warm temperatures associated with a frontal passage. Red Flag Watch was also issued for eastern Montana for the same period for gusty westerly winds and low humidities. The Canyon Creek Fire was obviously in a warm, dry sector in front of the approaching cold front. Winds during the night would remain light to calm. Afternoon temperatures ranged from the mid-80's to the lower 90's. Missoula reported a high temperature of 94 degrees which set a new high temperature mark for the date. The previous record temperature had been established in 1960 at 93 degrees. Glasgow reported winds of 10 to 20 MPH, while the remaining portions of the state generally had light winds. Idaho reported clear but smokey skies with similar afternoon temperatures as Montana. Washington had low clouds and drizzle in the west with temperatures mostly in the 60's from the cold front moving in off the Pacific. The front moved slower than expected and did not arrive in the Region during the afternoon or night.

SEPTEMBER 6 (Julian Date 250)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 70.0
Seeley Lake Ranger Station; 3-day running mean ERC: 43.3
Gleason's Resort; 3-day running mean ERC: 60.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.0%
Gleason's Resort; 3-day running mean 10 Hr: 4.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 10-2%
Monture, 24 hr High-Low range, 10 Hr fuel: 15-3%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 18-3%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 17-7%
Spotted Bear LO, 24 hr High-Low range, 1 Hr fuel: 11-1%
Spotted Bear LO, 24 hr High-Low range, 10 Hr fuel: 31-2%

BEHAVE Fuel Moisture:

(West Zone) 24 hr High-Low range, 1 Hr fuel: 9-4% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%
24 hr High-Low range, 1 Hr fuel: 10-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%

(East Zone) 24 hr High-Low range, 1 Hr fuel: 14-4% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 4%
24 hr High-Low range, 1 Hr fuel: 17-4% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%

RAWS Fire Weather:

Monture 24 hr temperature range: 51-85F
Monture 24 hr relative humidity range: 11-46%
Monture 24 hr average 20 ft wind speed range (MPH): 1-20
Monture 24 hr range of maximum wind gusts (MPH): 4-42
(Monture 1400 hrs readings; 79F, 21%, 7 MPH)
(Monture most extreme readings 1800 hrs; 84F, 11%, 20 MPH)
Benchmark 24 hr temperature range: 39-79F
Benchmark 24 hr relative humidity range: 11-71%
Benchmark 24 hr average 20 ft wind speed range (MPH): 2-14
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):5-57
(Benchmark 1346 hr readings; 78F, 17%, 11 MPH gusts to 35
(Benchmark most extreme readings 1746 hrs; 77F, 11%, 11 MPH)
Silver King LO 24 hr temperature range: 54-67F
Silver King LO 24 hr relative humidity range: 12-24%
Silver King LO 24 hr average eye level wind speed range (MPH): 16-30
(Silver King LO 1400 hr readings; 64F, 24%, 16 MPH)
Spotted Bear LO 24 hr temperature range: 51-70F
Spotted Bear LO 24 hr relative humidity range: 17-51%
Spotted Bear LO 24 hr average 20 ft wind speed range (MPH): 10-25
Spotted Bear LO 24 hr range of maximum 20 ft wind gusts(MPH): 20-54
(Spotted Bear LO 1418 hr readings; 69F, 18%, 24 MPH gusts to 54)
(figures 87 - 92)

West Zone Fire Behavior: The day started with a strong inversion in the North Fork of the Blackfoot and McDermott Creek drainages which did not break up until the front started to arrive at approximately 1230 hrs. As expected the fire became immediately active. After the inversion broke there were 3-4 ft flame lengths from surface fuels beneath the tree canopy, during the early afternoon this progressed to strong torching with flame lengths two times the tree heights (Lolo National Forest video as interpreted by Bushey).

At 1145 hrs the Silver King Lookout started to experience an increase in wind speed. The first report of a convection column was also made from the Silver King Lookout at 1315 hrs at which time the lookout reported wind speeds of 18 MPH with gusts in to the 20's. Winds rapidly increased at all locations on the fire. By 1600 hrs the lookout was completely socked in by smoke to the north and west and had wind speeds in to the 30 MPH range.

With the development of the winds from the southwest the fire moved up the east side of the North Fork of the Blackfoot, and up McDermott Creek to the

Figure 87. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and precipitation measurements for September 6 - September 10, 1988 (MST).

Fire Weather

Monture RAWS (333333)

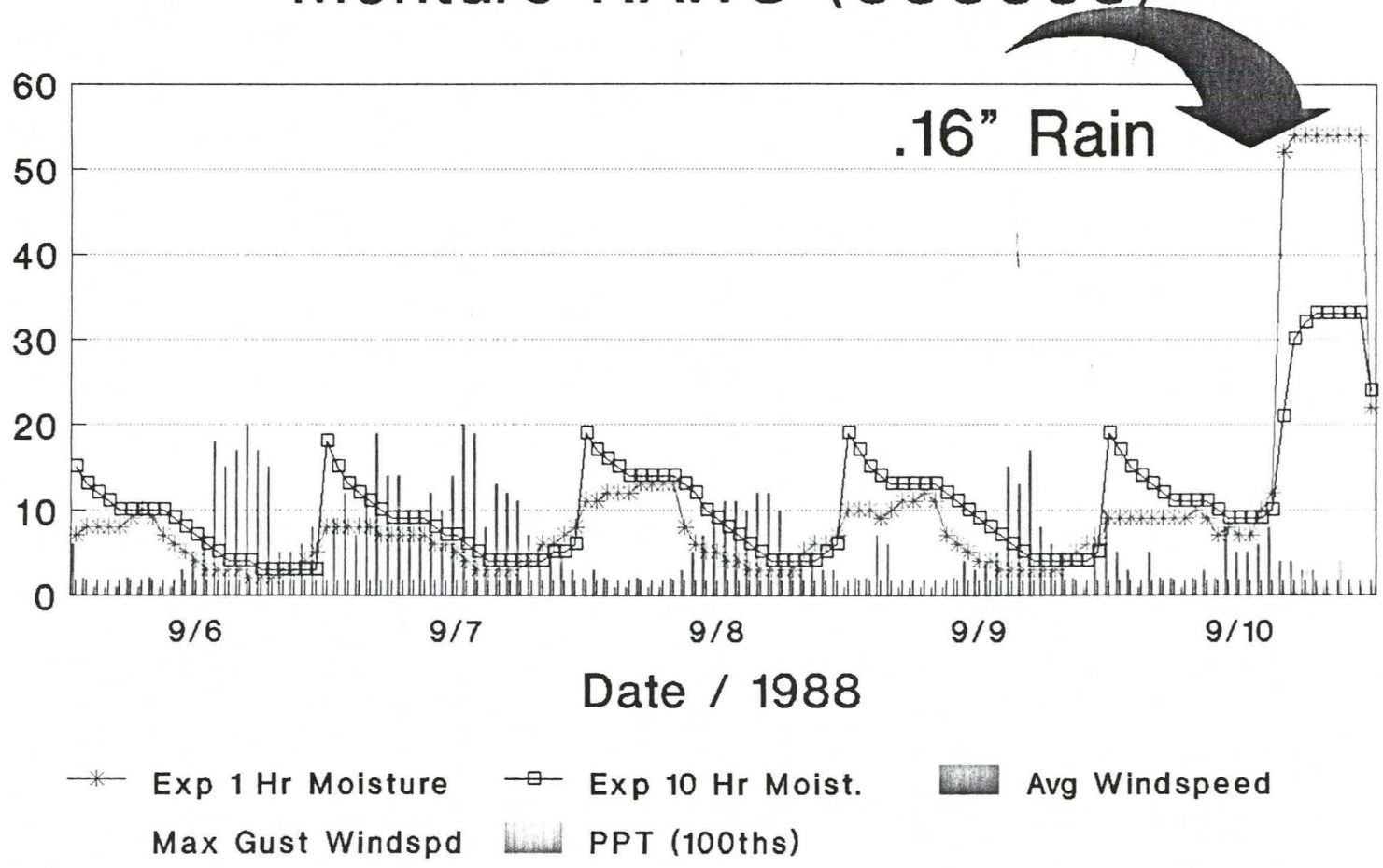


Figure 88. Monture RAWS Station air temperature, relative humidity, average wind speed, maximum gust wind speed, and precipitation measurements for September 6 - September 10, 1988 (MST).

Fire Weather

Monture RAWS (333333)

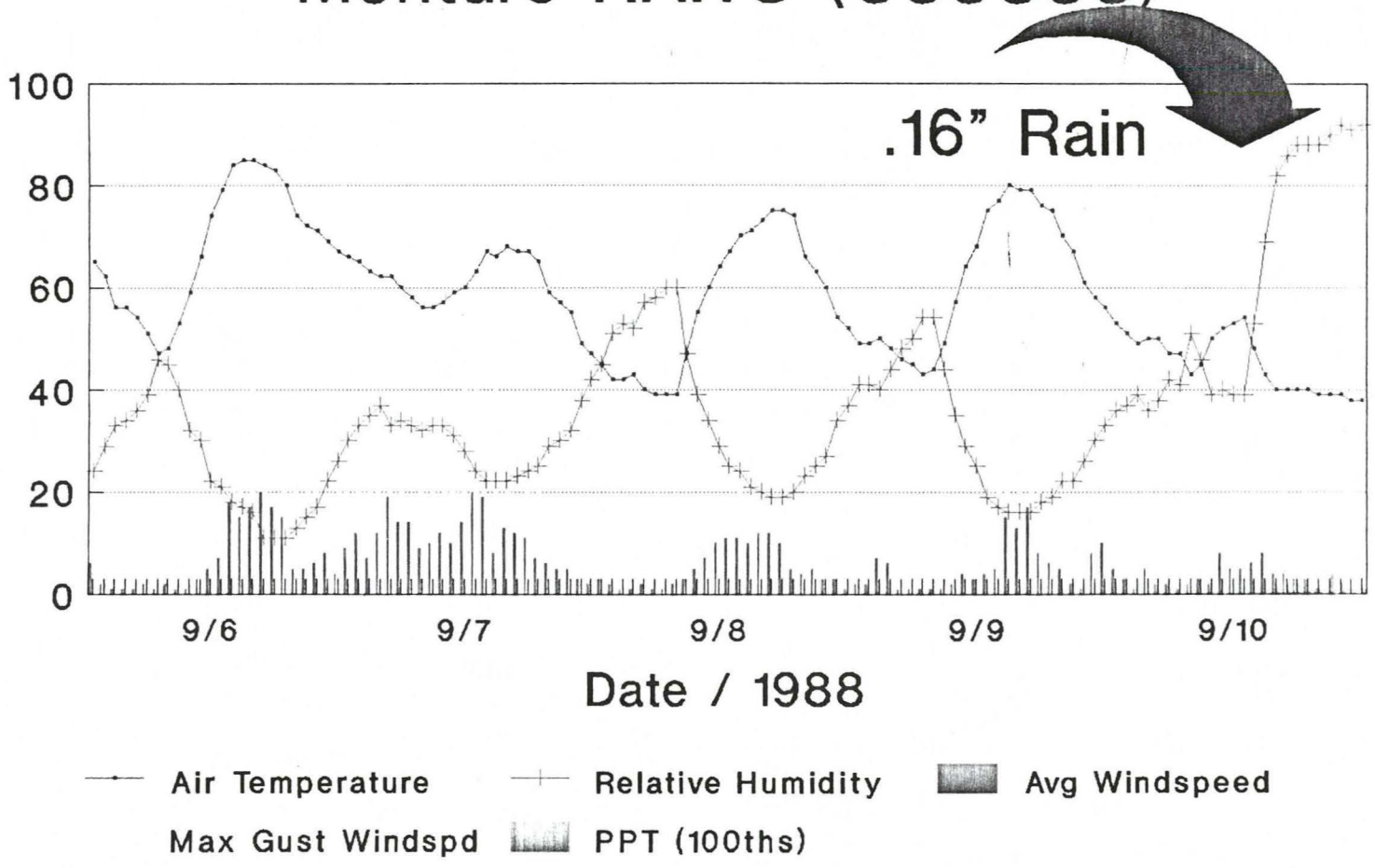


Figure 89. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and precipitation measurements for September 6 - September 10, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)

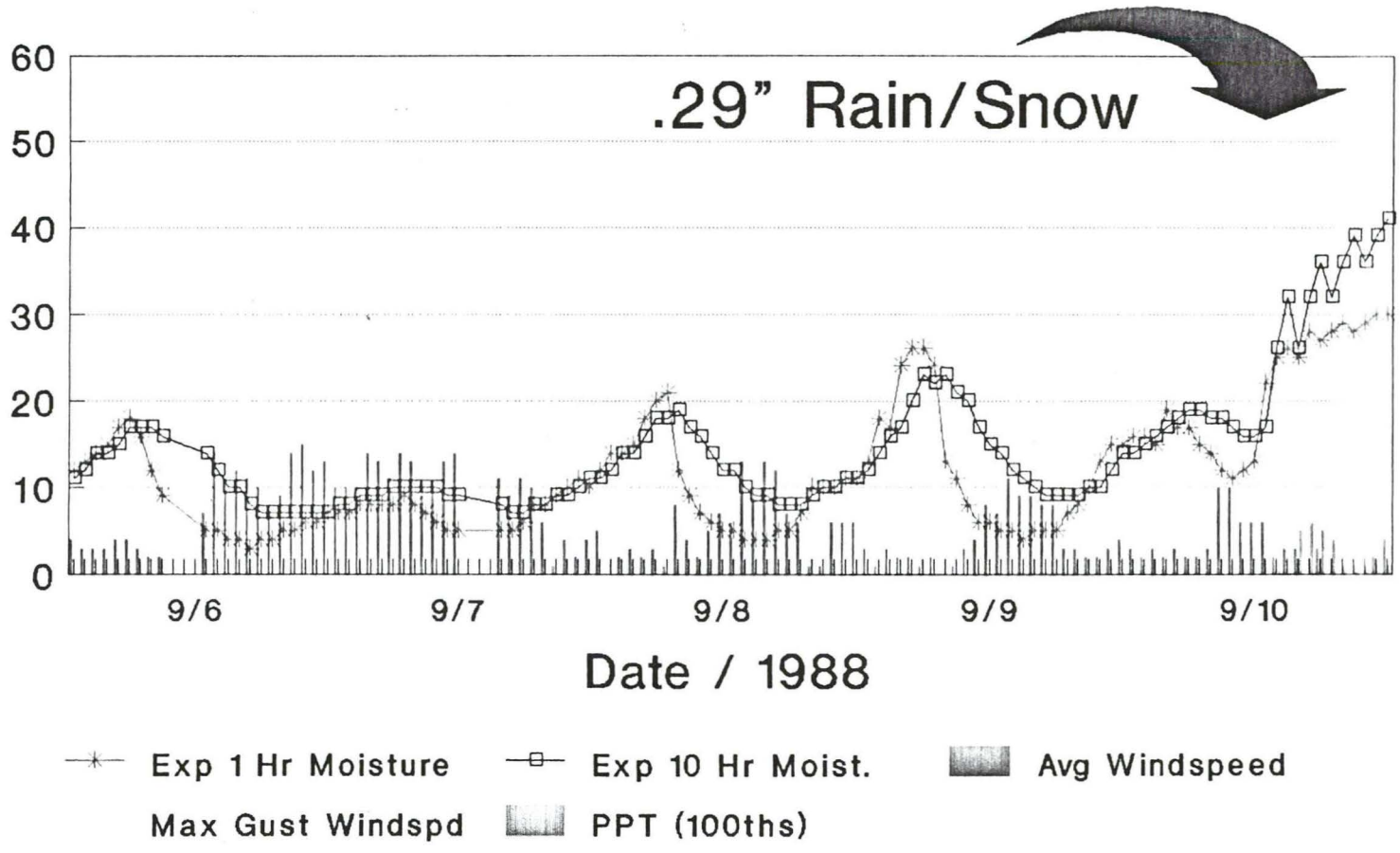


Figure 90. Benchmark RAWS Station air temperature, relative humidity, average wind speed, maximum gust wind speed, and precipitation measurements for September 6 - September 10, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)

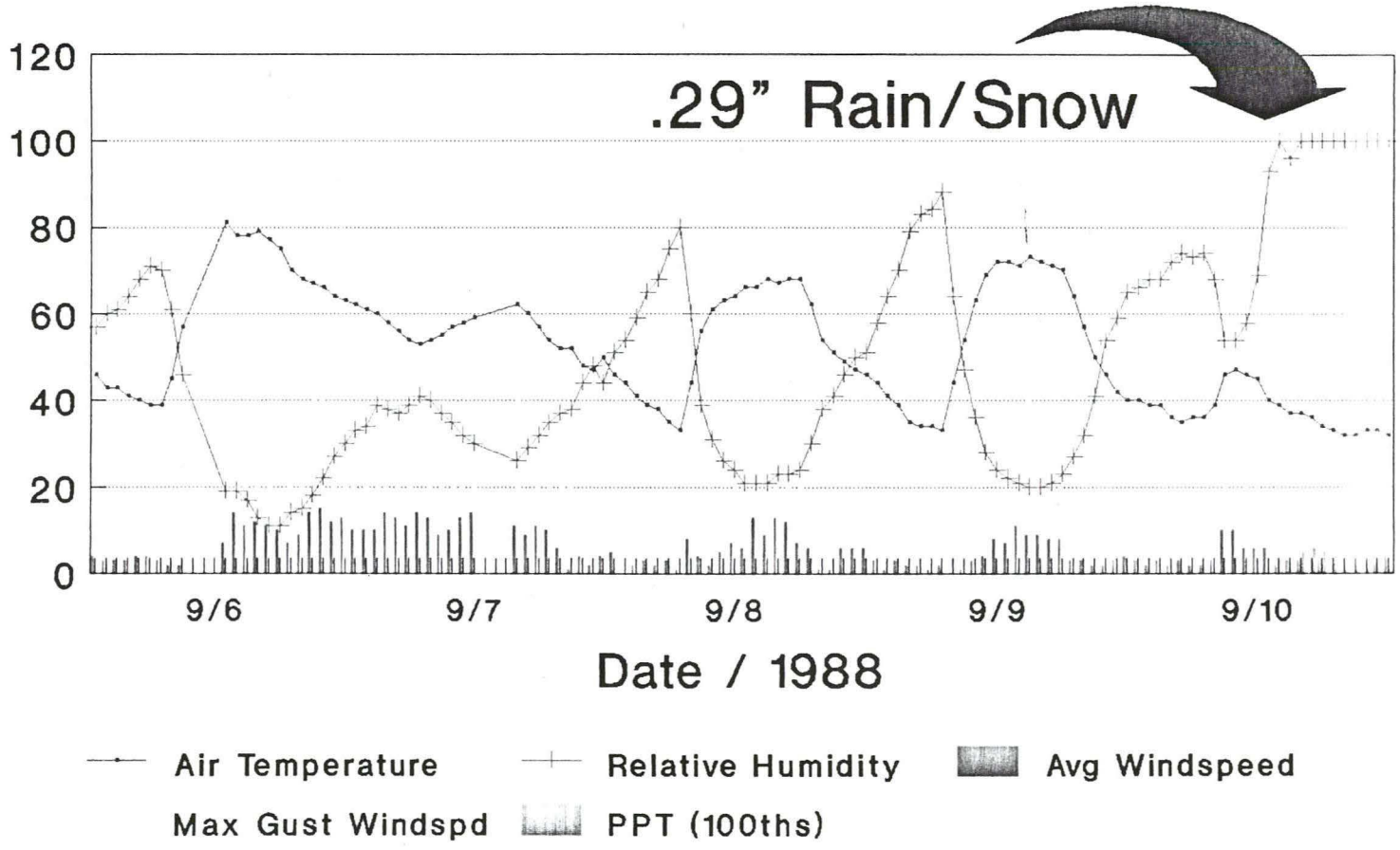


Figure 91. Spotted Bear Lookout RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, and maximum gust wind speed measurements for September 6 - September 10, 1988 (MST).

Fire Weather

Spotted Bear Lookout RAWS (3248D408)

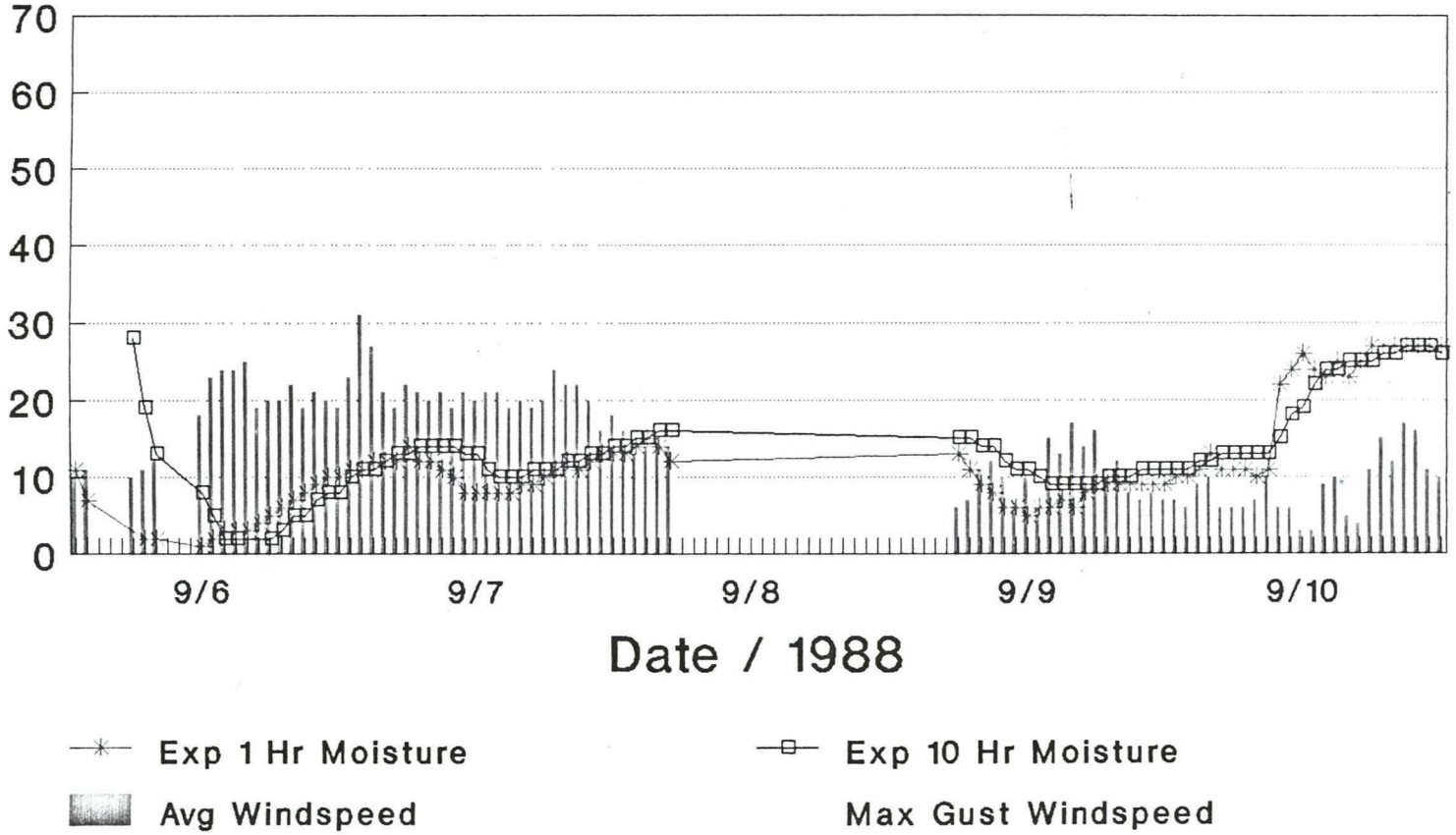
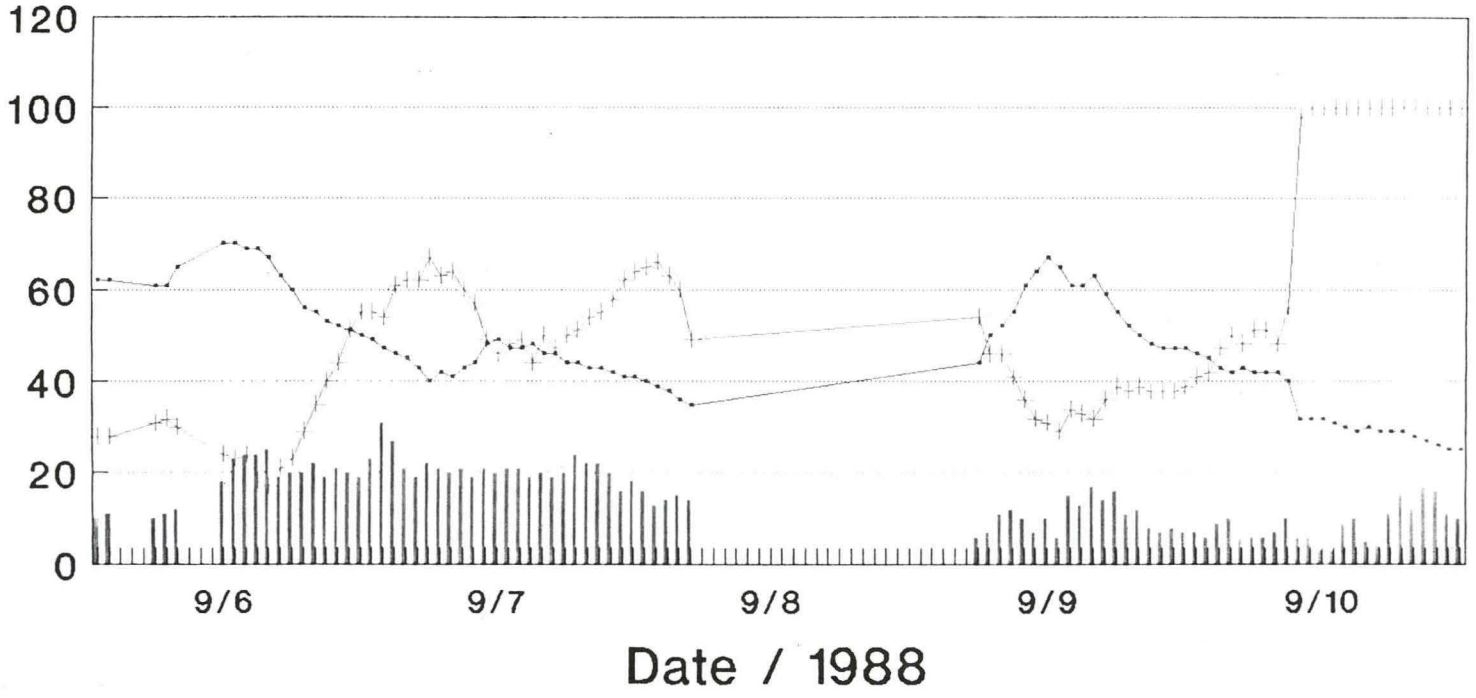


Figure 92. Spotted Bear Lookout RAWS Station air temperature, relative humidity, average wind speed, and maximum gust wind speed measurements for September 6 - September 10, 1988 (MST).

Fire Weather

Spotted Bear Lookout RAWS (3248D408)



wilderness boundary. This portion of the fire would burn approximately 5 miles to the east, reaching the East Fork of Mineral Creek which it then spotted across. From this point the fire would only burn about another two miles before encountering additional burned area from a run starting in the Bugle Mountain area. Wind shifts to the northwest caused some of this fire's southeast flank to temporarily become a front with some minor advances. Also, the fire moved south down the Blackfoot River halfway through Section 34 on the west side and into Section 2 on the east side. A strong northwest component of the wind was also to exert itself in the late afternoon on this portion of the fire, but the draft from the fire going up canyon on the Blackfoot and McDermott Creek negated it's effect. In the area of the Lake Creek Division fire camp the afternoon extreme burning conditions were; DB 75-80F, RH 10-20%, winds west to northwest 15-20, gusts to 30 (Carlson, 1988).

Fire activity in the Mineral Creek and Bugle Mountain area started picking up about 1200 hrs and continually built in to a major run which burned throughout the night. It was in this general vicinity that the Silver King Lookout first noted the development of a strong convection column about 1315 hrs. Strong westerly flow pushed the fire from Bugle Mountain across the East Fork of the North Fork of the Blackfoot River, across the Landers Fork over Sheep Mountain and Blacktail Pass onto the Lewis and Clark National Forest and into the Falls Creek drainage on the Lewis and Clark National Forest. During the late afternoon Jerry Burns (Helena National Forest, Lincoln Ranger District) rode in on horseback to retrieve a trail crew in the Middle Fork Creek portion of the Landers Fork. Jerry and the crew spent the night on top of Crow Peak (Bonney, 1988) surrounded by the fire.

The fire run from Bugle Mountain appears to have begun shortly after an aerial observer noted the fire's position in that area at 1805 hrs. This appears to have been the principal location for initial fire spread in this area, though additional hot spots and fireline existed on the fire perimeter to the north of this location as well. By 1900 hrs Jerry Burns observed the fire heading in his direction along the East Fork of the Blackfoot River and south of Twin Lakes. This fire had spread from the Mineral Creek area covering approximately 3.0 miles since about 1315 hrs when the column was first spotted. Assuming from the aerial observers remarks that the fire had reached the ridge on Bugle Mountain at 1805 hrs, about 2.7 miles had been covered by the fire during the previous 55 minutes (rate-of-spread of 238 chains per hour, or 2.97 miles per hour). Calculated fire behavior values for the mean and range crown fuel loads in the vicinity were flame lengths of 90 feet (range 70 - 175 feet), and a unit energy of 2,600 BTU/FT^2 (range 1,600 - 6,300 BTU/FT^2). The fire was wind driven with unit power of fire / unit power of wind ratios of 0.17 - 0.34 (Rothermel, 1991). Wind speeds during this period were calculated to average about 44 MPH, with a range of approximately 38 - 54 MPH. During the next ten minutes Jerry Burns observed the fire moving toward him covering about 1.5 miles in ten minutes (720 ch/hr, 9.0 MPH). To achieve this high rate-of-spread the wind speeds driving the fire would have needed to achieve approximately 100 MPH, with a range between 87 - 122 MPH. This fire was moving directly up the drainage in an easterly direction and had up to this point an average rate-of-spread for its entire run during the previous 65 minutes of 3.87 miles per hour (310 ch/hr). To have achieved this high rate-of-spread the fire within the drainage would have had to been experiencing up drainage wind speeds of between 47 - 67 MPH, with an average of about 57 MPH for the duration of the run under no slope conditions. With a typical surface fuel load represented by Fuel Model 10 (range Fuel Model 9 - 12) and an average crown biomass of 3.9 tons per acre (range 1.1 - 14.37 tons per acre) the fire

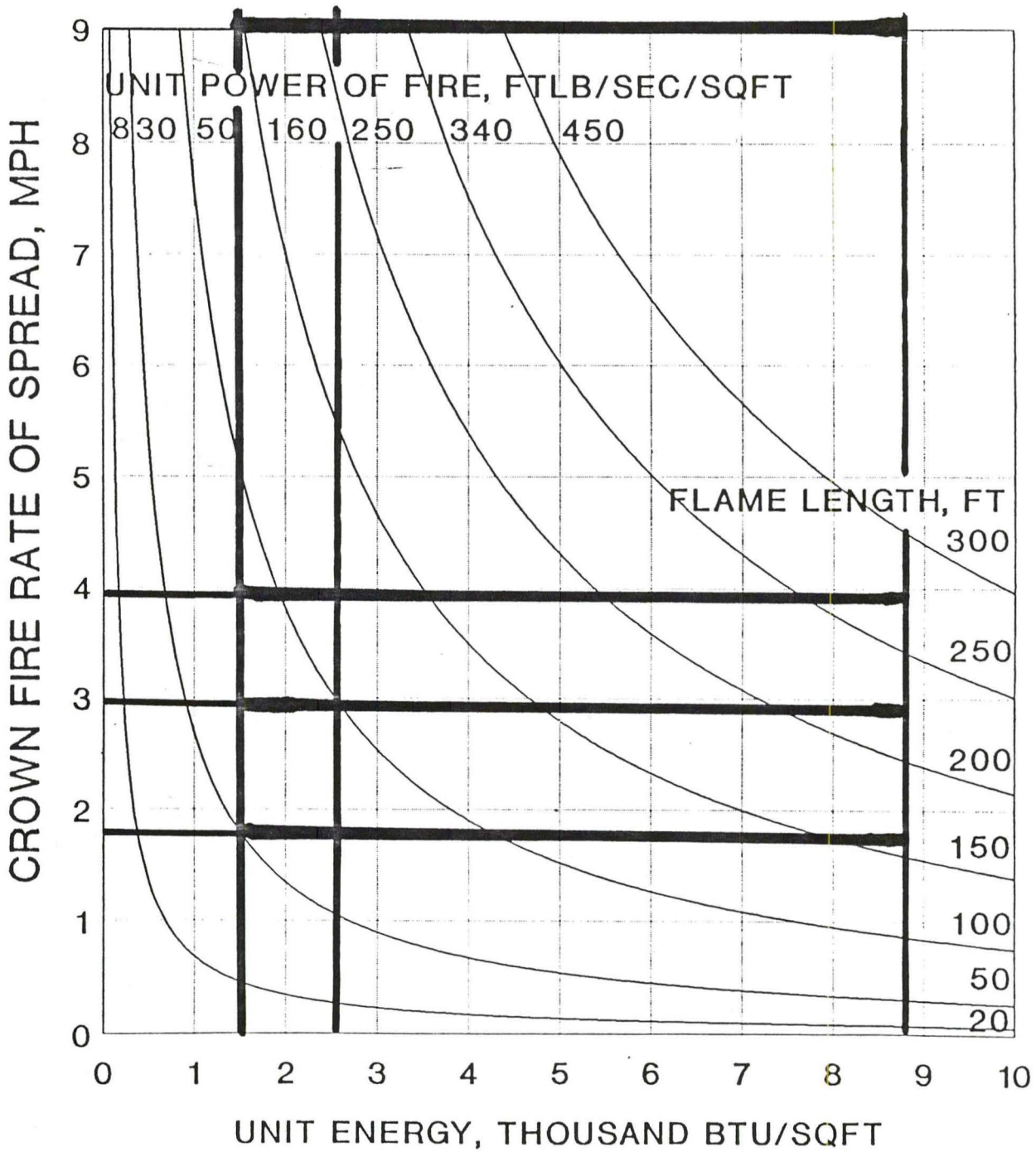
would have had an average above crown flame length of about 170 ft (range 120 - 220 ft), with a energy release of approximately 6,400 BTU/FT^2 (range 1,500 - 8,800 BTU/FT^2)(figure 93). The fire would have been wind driven with an average unit power of fire / unit power of wind ratio of 0.15.

Fire in the more mountaious terrain to the north of the drainage was moving at a lower spread rate because it took another 35 minutes before it reached the ridgetops to the south of Pyramid Peak and to the west of the Landers Fork. This fire is estimated to have had a rate-of-spread of approximately 1.8 miles per hour (145 ch/hr) during the previous two hours as it traveled up slopes and over ridges on to adjacent slopes (average flame length 75 ft, range 50 - 160 ft)(Rothermel, 1991). Calculated wind speeds needed to produce the 1.8 MPH rate-of-spread would have ranged from 27 - 38 miles per hour with an average of 32 miles per hour. By this time, the fire in the more level East Fork of the Blackfoot drainage had passed the entrance to the Landers Fork and Jerry Burns and the trail crew had that route of escape cutoff with fire to the south and west of their position. During the next five minutes the fire spotted with burning embers and gasses another 2.1 miles to the east moving the fire front across the Landers Fork drainage and eliminating the trail crews use of the last remaining trail across the Continental Divide. With this additional spotting and ignition of the east slope above the Landers Fork the average rate-of-spread increased to 2.9 MPH (234 ch/hr) matching the earlier fire behavior of the fire down in the drainage bottom. During the peak afternoon burning conditions in the West Zone the Probability of Ignition peaked at 60% with the rising relative humidities and dropping air temperatures. Calculated maximum spotting distance for the crown fire run in either the valley bottom of the East Fork of the Blackfoot River or in the mountainous terrain surrounding the drainage would have varied with the wind speed; 35 MPH a distance of 1.1 miles, 45 MPH a distance of 1.4 miles, 55 MPH a distance of 1.7 miles, and with wind speeds up to 65 MPH firebrands could have traveled up to 2.0 miles. The Probability of Ignition dropped throughout the night achieving a low value of 30% during the early morning hours.

From this point the fire continued to burn during the night in a west - northwest direction across the Continental Divide to the north of Caribou Peak, into the West Fork of Falls Creek, over the north slope of Blowout Mountain, and eventually ending it's run at the timber edge on the top of Falls Creek Ridge. It is unknown at what time during the next morning that the fire reached Falls Creek Ridge. This portion of the fire run covered a distance of about 20.8 miles. If the fire was able to sustain a spread rate of 2.9 MPH it would have reached the end of the run 5.5 hrs later, or about 0115 the next morning.

East Zone Fire Behavior: Helicopter travel over the East Zone of the fire and in to Welcome Creek was very rough early in the morning. Traveling about 200-300 ft above the fire the winds were estimated to be 30 MPH at 1000 hrs. Change in wind from previous days pattern was evident at this time. More fire activity was occurring between 0900-1000 hrs than had during previous days. The helicopter pilot didn't think he could return to the helibase because of the winds, and didn't; flying was over. Crews were still positioned along Bald Bear Creek, and along the edge of Pass Creek. Much of the area along the Dearborn River between Bald Bear Creek and Welcome Creek Guard station had not been burned out. Because of rapidly increasing fire behavior, and the danger of crews being trapped, plans were made to pull back in to safer areas. The first crews to be moved was in the Pass Creek area. Spot fires between crews and the Elk Pass trail started to heat up. A wind shift along the river bottom

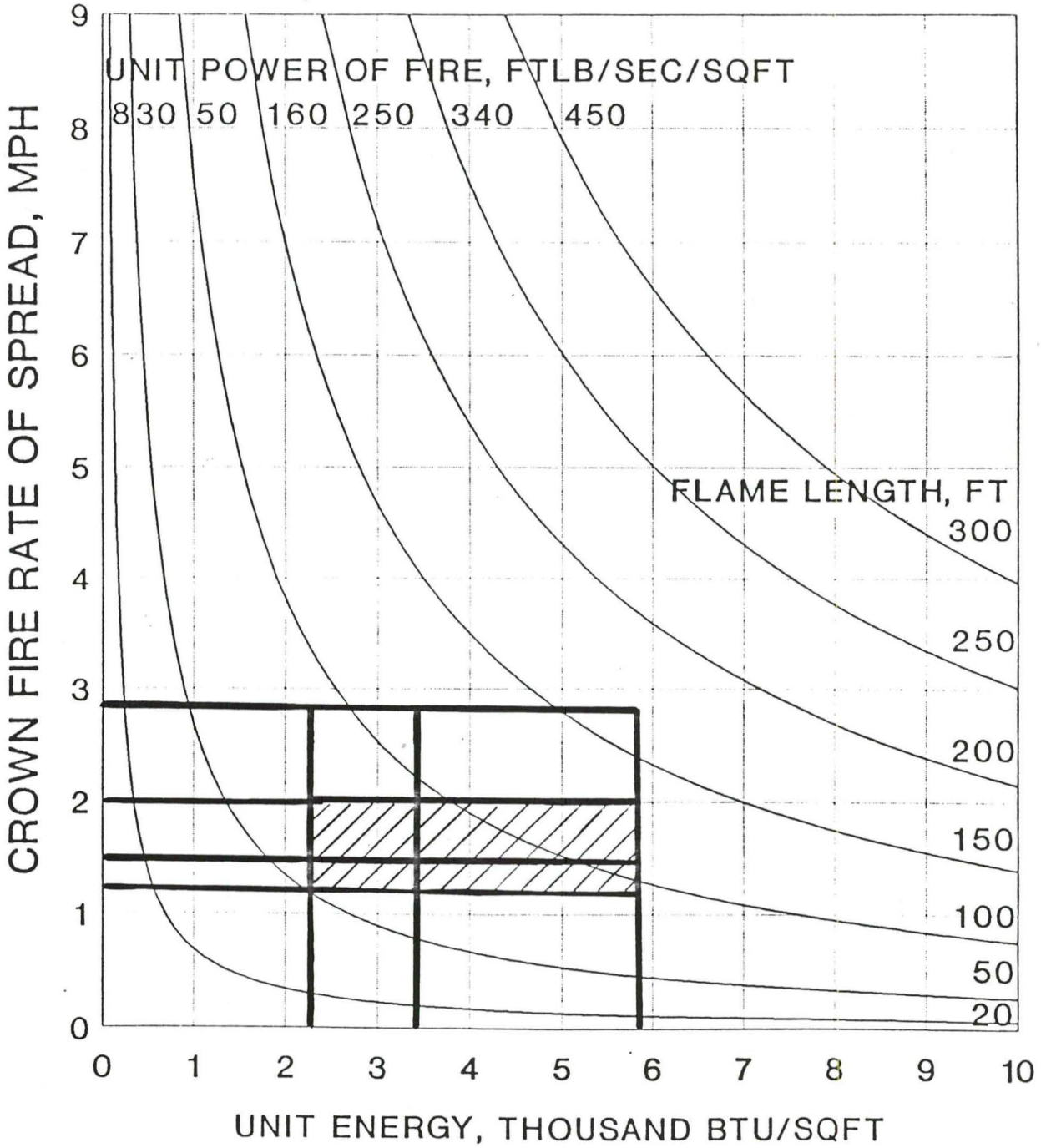
Figure 93. Detail from the Crown Fire Nomogram (Rothermel, 1991) for the September 6, 1988 fire behavior in the East Fork of the North Fork of the Blackfoot River and the mountainous terrain to the north during the Canyon Creek Fire. Lowest horizontal line represents the initial rate-of-spread in mountainous terrain; the second line from the bottom the eventual average spread in mountainous terrain. The third horizontal line is the average rate-of-spread in the East Fork of the North Fork of the Blackfoot River. The uppermost horizontal line represents a short term period of very high spread observed within the valley bottom of the same drainage.


UNIT POWER OF FIRE, FTLB/SEC/SQFT
830 50 160 250 340 450
FLAME LENGTH, FT
300
250
200
150
100
50
20
CROWN FIRE RATE OF SPREAD, MPH
0 1 2 3 4 5 6 7 8 9
UNIT ENERGY, THOUSAND BTU/SQFT
0 1 2 3 4 5 6 7 8 9 10

was the first evidence on the ground of a change, adjacent slopes were protected by timber and the initial change in the winds was not as evident on the slopes. At this time crews in Bald Bear Creek were pulled out and tied in with the Redmond Hot Shot Crew above the Welcome Creek Guard Station. These crews (110 people) were placed in a meadow safety zone. No radio contact was established with the remaining crew in Jackie Creek. All of Division A would be endangered from a fire run from the southwest. When the fire started it's run the Jackie Creek crew became involved in a shelter deployment. The deployment involved 5-6 persons, and shelters were opened 1/2 hr before they were used. The wind blew all night. From a safety zone at the helispot in the middle of the river (gravel bar) the fire glow grew and ebbed all night, winds were squirrelly and quite loud. Crown fire passed over all of the underburns accomplished in Fuel Model 9 types, long distance spotting went over the areas previously burned out (Peila interview). During the afternoon the Probability of Ignition on the East Zone peaked at 70% over the entire range of elevations at which the fire was burning.

It's unclear when the fire run in the upper Dearborn River started but it was most likely between 1315 - 1445 hrs; the time the Silver King Lookout noticed a strong convection column in the vicinity of Mineral Creek and the time crews in the area reported extreme fire behavior conditions. From the burning patterns evident from aerial photographs after the fire run it appears the fire grew rapidly from many different areas along the extensive fire perimeters established on August 29th and 30th. Burning patterns become very irregular throughout this northern fire run area because of complicated landscape patterns of vegetation and terrain. There appears to have been at least two separate major fire runs in the area generally north of the Dearborn River. The run most likely to have started first was near the fire crews near the head of the Dearborn drainage, this fire spread to the northeast initially then later spread east and southeast staying for the most part north of Elk Creek. The second fire run was south of Elk Creek and initiated in the upper ends of Cataract and Bailey Basins. Because the fire became active in so many different locations along this front, and there was insufficient time / location markers to monitor the fire's many locations the fire behavior calculations are "best average estimates." Crown biomass measurements from similar forested stands located on the Lewis and Clark National Forest indicate an average crown biomass of 5.5 tons per acre (range 0.27 - 12.13 tons per acre). Surface fuel loadings were a complex mosaic of Fuel Models 9 and 10 with isolated pockets of heavier loadings typical of models 11 and 12. Using the average crown biomass, Fuel Model 10, no slope conditions, and average wind speeds of 30 MPH to represent the overall conditions on the fire provides some fire behavior estimates. The crown fire rate-of-spread would have ranged from 1.2 to 2.0 MPH with above crown flame lengths of 65 - 90 ft (75% confidence level). Average fire behavior values for the mean fuel load would have been approximate flame lengths of 75 ft, and a rate-of-spread of 1.5 miles per hour. Average energy released would have approximately equalled 3,400 BTU/FT^2 (range 2,200 - 6,900 BTU/FT^2)(figure 94). The fire was wind driven with a unit power of fire / unit power of wind ratio of between .3 and .5 (75% confidence level. For short tinme intervals the crown fire may have had fire behavior with rates-of-spread as high as 2.8 miles per hour, and flame lengths ranging from 80 - 170 ft in height. Calculated maximum spotting distance for a firebrand from the fire in the Dearborn River area is less than the spotting distance from the fire run taking place to the south around the East Fork of the North fork of the Blackfoot River. This is mostly due to the difference in

Figure 94. Detail from the Crown Fire Nomogram (Rothermel, 1991) for the September 6, 1988 fire behavior in the drainages north and east of the Dearborn River on the Lewis and Clark National Forest during the Canyon Creek Fire. Shaded zone represents the fire behavior within the 75% confidence level zone.


UNIT POWER OF FIRE, FTLB/SEC/SQFT
830 50 160 250 340 450
FLAME LENGTH, FT
300
250
200
150
100
50
20
CROWN FIRE RATE OF SPREAD, MPH
UNIT ENERGY, THOUSAND BTU/SQFT
0 1 2 3 4 5 6 7 8 9 10

mean forest cover heights in the two different zones. Maximum spotting distance for the crown fire runs taking place in the East Zone near the Dearborn River ranged from 0.9 miles with a 35 MPH wind speed, 1.2 miles with winds of 45 MPH, with winds of 55 MPH a distance of 1.5 miles, and under 65 MPH winds a distance of up to 1.8 miles.

The southern edge of this northern portion of the fire run broke out of the timber above Bean Lake at approximately 2225 hrs after the fire made a nearly direct easterly run of 6.8 miles from Cataract Basin. This portion of the fire was also observed at the head of Pole Gulch at 2137 hrs and entered the grasslands by Bean Lake a little less than an hour later, a distance of about 2 miles in about 48 minutes. At the lower end of the rate-of-spread average, 1.4 MPH, the entire eastern run would have lasted about 4.8 hours and have started about 1740 hrs.

It is possible that different portions of the fire front on this northern run erupted at different times. Areas within the interior of the fire, especially along Elk Creek, were reportedly missed by the fire, then hit by a flaming front several hours later. The Elk Creek Fire Camp was one example of this. The main fire front to the south of Elk Creek had been past for about five hours when the camp had to be defended from two different advancing fire fronts at 0200 hrs the next morning. These fronts appear to have been flanking fires from the main fire runs to the north and south of the Fire Camp. It's possible that there was considerable interaction between the different advancing fronts causing increased and erratic fire behavior not accounted for by available fire behavior models.

Along most of the timber / grassland ecotone the fire emerged from the forest between 2100 - 2300 hrs. Once in to the grassland fuel the fire burned in typical wind driven fingering patterns for up to 7.2 miles. These grass fires were strongly influenced by bare ridges (reefs), small lakes, roads, heavily grazed pastures, and irrigated fields which blocked or diverted fire spread. These barriers combined with declining wind speeds, and rising humidities and fine fuel moisture content eventually stopped the eastward spread of the fire.

Another interesting feature of the fire behavior involves area unburnt between the main north fire run along the Dearborn and Elk Creek drainages, and the more southerly run starting near Mineral Creek and Bugle Mountain and burning toward Blowout Mountain and the Falls Creek drainage. The initial feature dividing these two runs was the 1979 Cabin Fire. This earlier fire had prevented earlier further Canyon Creek Fire penetration up the East Fork of the Blackfoot River. Fuel within this relatively recent, and also relatively small fire induced mosaic was insufficient to allow fire spread. It is interesting to speculate how this 1979 fire might have influenced spread in 1988 if the 1979 fire had not been suppressed. Also from examination of aerial photos taken after the 1979 fire it can be seen that it was following the mosaic pattern of a much earlier fire running to the northeast and in to the Continental Divide.

There was a relatively small fire front on the Canyon Creek Fire which started to the north of the Cabin Fire and which made a run of about 4.5 miles before running in to the natural barrier created by Crow Mountain and adjacent bare ridge tops. To the south of the Cabin Fire the main wind driven southern run took place, diverted slightly by the southeastern corner of the Cabin Fire. The initial diversion, and influence of the wind was sufficient to prevent the area between the Cabin Fire and Crow Mountain from being burned. When the main southern run encountered the southern ridge from Crow Mountain

the fire was again diverted sufficiently to maintain it on a more easterly course rather than northeastern as it had been tending toward. There were several locations where the fire nearly broke through the barrier created by the Crow Mountain southern ridge, and if it had the fire would have entered in to Carmichael Basin and the Grassy Hills area of the Dearborn River drainage burning an extensive area which has remained essentially fire free since before the 1889 fires swept the area.

Because the strong fire behavior continued throughout the night, mapping of this individual day's burned acreage was not possible. Total burned acreage for September 6th is included within the acreage total for the extended burning period into the 7th.

0000 hrs. Monture RAWS unit records the temperature dropping to 65F, relative humidity rising to 24%, average wind speed was 6 MPH from the north with gusts to 14 MPH from the north - northwest.

0120 hrs. Spot Fire Weather Forecast For the Canyon Creek Fire, Lake Creek Division. Dry Pacific cold front located thru western Alberta trailing down thru central Washington. Front moving eastward 30 MPH to reach burn area around 1000 MDT.

For Today...
Weather...scattered clouds
Temperature...Max 82 at 4800 ft, 75 at 6700 ft
Humidity...min 12%
Wind..eye level..southwest 10-20 MPH shifting 1000 MDT to west 10-20 MPH. Wind increasing west-northwest 15-30 MPH 1300 MDT, possibly reaching 35 MPH at peaks and ridges later in afternoon.

For Tonight...
Weather...scattered to broken clouds
Temperature...min 45 at 4500 ft min 38 at 6700 ft
Humidity...max 45%
Wind..eye level..west 15 to 25 MPH

Outlook for Wednesday...Slight chance of showers and cooler with west winds 15 to 25 MPH. (Missoula Fire Weather Office)

0046 hrs. Benchmark RAWS unit records the temperature dropping to 43F, relative humidity rising to 60%, average wind speed of 2 MPH out of the north - northeast.

0100 hrs. Monture RAWS unit records the temperature dropping to 62F, relative humidity rising to 29%, average wind speed was 2 MPH from the south with gusts to 10 MPH from the north.

0146 hrs. Benchmark RAWS unit records the temperature steady at 43F, relative humidity rising to 61%, average wind speed of 3 MPH out of the north - northeast.

0200 hrs. Monture RAWS unit records the temperature dropping to 56F, relative humidity rising to 33%, average wind speed was 1 MPH from the south - southwest with gusts to 5 MPH from the north - northeast.

0246 hrs. Benchmark RAWS unit records the temperature dropping to 41F, relative humidity rising to 64%, average wind speed of 3 MPH out of the north.

0300 hrs. Monture RAWS unit records the temperature stays at 56F, relative humidity rising to 34%, average wind speed was 1 MPH from the north with gusts to 10 MPH from the north - northwest.

0346 hrs. Benchmark RAWS unit records the temperature dropping to 40F, relative humidity rising to 68%, average wind speed of 4 MPH out of the north - northeast.

0400 hrs. Monture RAWS unit records the temperature dropping to 54F, relative humidity rising to 36%, average wind speed was 1 MPH from the south with gusts to 5 MPH from the north.

0446 hrs. Benchmark RAWS unit records the temperature dropping to 39F, relative humidity rising to 71% (highest relative humidity reading for this day), average wind speed of 4 MPH out of the north.

0500 hrs. Monture RAWS unit records the temperature dropping to 51F, relative humidity rising to 39%, average wind speed was 2 MPH from the north - northwest with gusts to 6 MPH from the north - northwest.

0546 hrs. Benchmark RAWS unit records the temperature steady at 39F, relative humidity starting to drop and reading 70%, average wind speed of 3 MPH out of the north - northeast.

0600 hrs. Monture RAWS unit records the temperature dropping to 47F, relative humidity rising to 46%, average wind speed was 1 MPH from the southwest with gusts to 5 MPH from the north - northeast. These would be the lowest temperature and highest relative humidity readings for the day.

0625 hrs. "Contact Rich Carlson with weather information; winds southwest 10-20 at Spokane, mild front mid morning but no rain." (Canyon Creek Fire, Lake Mountain Division, radio log, transmission from Rich Lasko FBA.)

0646 hrs. Benchmark RAWS unit records the temperature starting to rise at 45F, relative humidity begining to decline at 61%, average wind speed of 2 MPH out of the south - southwest with gusts to 8 MPH from the northeast.

0700 hrs. Monture RAWS unit records the temperature starting to rise to 48F, relative humidity drops to 45%, average wind speed was 2 MPH from the south - southeast with gusts to 4 MPH from the east - northeast.

0700 hrs. "Clear, very smoke(y) Ten mile visibility." (Silver King radio log.)

0746 hrs. Benchmark RAWS unit records the temperature rising rapidly to 57F, relative humidity dropping to 46%, average wind speed of 2 MPH out of the south - southwest with gusts to 9 MPH from the east.

0800 hrs. Monture RAWS unit records the temperature rising to 53F, relative humidity drops to 40%, average wind speed was 1 MPH from the east with gusts to 4 MPH from the east - southeast.

0846 hrs. Gap in the data collection from the Benchmark RAWS unit.

0855 hrs. "2000 ft 25 MPH, 5000 ft 30 MPH, 8000 ft 35 MPH, 15000 ft 40 MPH. Losing some energy as it (frontal system) hits high pressure, still windy. Choteau Ranger Station Dispatch to Augusta Information Station. (Augusta Information Station, radio log.) [Note; This message references the 0600 hrs radiosonde readings from Spokane, Washington as mentioned in the RICO Fire Behavior Service Center morning report.]

0900 hrs. DB 60, RH 19, wind 16 from the west (Silver King Lookout Weather log.)

0900 hrs. Monture RAWS unit records the temperature rising to 59F, relative humidity drops to 32%, average wind speed was 1 MPH from the south with gusts to 5 MPH from the east. [Note; there was considerable difference in relative humidity between the high elevation lookout readings and lower stations such as Monture.]

0900 hrs. The north half of the South Lake Timber sale area was burned. The fire had little activity (USDA Northern Region, 1989).

0946 hrs. Gap in the data collection from the Benchmark RAWS unit.

1000 hrs. DB 61, RH 17, wind 16 from the west - southwest (Silver King Lookout Weather log.)

1000 hrs. Monture RAWS unit records the temperature rising rapidly to 66F, relative humidity drops to 30%, average wind speed was 3 MPH from the south with gusts to 6 MPH from the south - southeast.

1025 hrs. "87S (helicopter) reporting heavy turbulence over the ridge." ... "Is 87S in the air now? Negative he went back because of the wind." ... "We have no wind here in camp, beginning to have 3 MPH winds." (Gates Park Fire Base Camp to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1046 hrs. Gap in the data collection from the Benchmark RAWS unit.

1100 hrs. DB 63, RH 23, wind 18 from the southwest - west (Silver King Lookout Weather log.)

1100 hrs. Monture RAWS unit records the temperature rising rapidly to 74F, relative humidity drops to 22%, average wind speed was 5 MPH from the east - southeast with gusts to 12 MPH from the south.

1118 hrs. Spotted Bear Lookout RAWS unit reaches maximum temperature for the day, 70F; relative humidity at 24% is dropping, average wind speed is 18 MPH from the south - southwest, gusts to 44 MPH from the same direction.

1130 hrs. Spot Fire Weather Forecast For the Canyon Creek Fire, Elk Creek Division. Red Flag. Frontal passage midday today, mainly wind with frontal system. Cooler westerly flow aloft with west to east pressure gradient tonight and Wednesday for windy conditions along with cooling and slight rise in humidities.

For Today...
Weather...becoming partly coudy
CWR...zero
Temperature...from 85 at 5000 ft to 78 at 6500 ft with 5 to 10 degrees cooling after frontal passage
Humidity...min 15 to 25% rising to 25 to 35% afternoon
Wind..eye level..southeast to southwest 5 to 15 with gusts 20 to 25 switching to westerly 15 to 25 with gusts 30 to 35 at times this afternoon
For Tonight...
Weather...partly cloudy
CWR...zero
Temperature...cooler tonight, mins 40 to 50 degrees
Humidity...better recovery max 50 to 60%
Wind..eye level..westerly 15 to 25 and gusty diminishing slowly during early nighttime becoming 5 to 15 MPH. Occasional gusts to 25 ridges / westerly exposures
Outlook for Wednesday...Cooler with low humidity 25 to 35%. Winds southwest to northwest 5 to 15 MPH with gusts during the afternoon to 25 MPH. High temperatures 60 to 70. (Missoula Fire Weather Office)

1139 hrs. "Winds are just starting 4 to 5 MPH from southeast." [Note; this was in Choteau.] (Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1141 hrs. A spot fire reported on Blowout Mountain by the Silver King Lookout is under observation by an aerial observer. (Lincoln Ranger District radio log.) This small spot fire was most likely a lightning holdover from storms which had tracked across the area during the middle of August (Wilson interview). [Note; fire on this mountain had been repeatedly reported since mid-August and one fire had been suppressed.]

1143 hrs. "Smoke outside Blowout Mountain Fire, near heli spot." (Silver King radio log.)

1145 hrs. "Reports major spotting on east side of river (North Fork of the Blackfoot River)..." (Canyon Creek Fire, Lake Mountain Division, radio log.)

1146 hrs. Benchmark RAWS unit records the temperature rising rapidly to 81F (warmest air temperature reading of the day from this station), relative humidity dropping to 19%, average wind speed of 7 MPH out of the east - southeast with gusts to 30 MPH from the south.

1147 hrs. "Winds increasing west / northwest 12-18 MPH." (Silver King radio log.)

1200 hrs. "Winds west 10-16 MPH. Visibility down to 5 miles." (Silver King radio log.)

1200 hrs. DB 65, RH 25, wind direction erratic (Silver King Lookout Weather log.)

1200 hrs. Monture RAWS unit records the temperature rising to 79F, relative humidity drops to 21%, average wind speed picking up at 7 MPH from the southeast with gusts to 31 MPH from the west - southwest.

1218 hrs. Spotted Bear Lookout RAWS unit temperature has remained constant at 70F, relative humidity continues to drop with a reading of 23%, average wind speeds are 23 MPH from the south - southwest with gusts to 48 MPH from the southwest.

1225 hrs. "We are beginning to pick up wind 8-10 MPH south /southeast." (Gates Park Fire Base Camp to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1240 hrs. "We are getting winds 8-15 MPH from the north." (Gates Park Fire Base Camp to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1246 hrs. Benchmark RAWS unit records the temperature starting to fall to 78F, relative humidity steady at 19%, average wind speed increasing to 14 MPH out of the southeast with gusts to 34 MPH from the east.

1300 hrs. "Winds increasing west steady 12, gusting 18. Column seen Mineral Creek area." (Silver King radio log.)

1300 hrs. DB 65, RH 22, wind 18 from the west, gusts to 20's (Silver King Lookout Weather log.)

1300 hrs. Monture RAWS unit records the temperature rising rapidly to 84F, relative humidity drops to 18%, average wind speed now 18 MPH from the south - southwest with gusts to 37 MPH from the south - southwest.

1315 hrs. Large column smoke seen from Mineral Creek area of Canyon Fire. Winds increasing west steady 16, gusting low 20's. Visibility poor." (Silver King radio log.)

1318 hrs. Spotted Bear Lookout RAWS unit temperature has dropped one degree to 69F, relative humidity rises slightly to 24%, average wind speeds are 24 MPH from the south - southwest with gusts to 45 MPH from the southwest.

1346 hrs. Benchmark RAWS unit records the temperature steady at 78F, relative humidity falling to 17%, average wind speed at 11 MPH out of the south - southeast with gusts to 35 MPH from the east - northeast.

1400 hrs. DB 64, RH 24, wind 16 direction erratic (Silver King Lookout Weather log.)

1400 hrs. Monture RAWS unit records the temperature rises to 85F, relative humidity drops to 17%, average wind speed at 15 MPH from the south - southwest with gusts to 38 MPH from the south - southwest.

1410 hrs. "Winds steady 16 MPH north / northwest, gusting to 20 MPH." (Silver King radio log.)

1416 hrs. "Ridge wind speed at 34 knots at 340 degrees." (Canyon Creek Fire, Lake Mountain Division Helibase log.)

1418 hrs. Spotted Bear Lookout RAWS unit temperature has remained constant at 69F, relative humidity drops to 18%, average wind speeds are 24 MPH from the south - southwest with gusts to 54 MPH from the southwest.

1429 hrs. "Indicating winds to 50 knots, retardant drops to continue." (Canyon Creek Fire, Lake Mountain Division Helibase log.)

1430 hrs. Wind 20, erratic (Silver King Lookout Weather log.)

1430 hrs. "Increasing winds west / northwest steady 20 MPH, gusting upper 20's - low 30's. Large column." (Silver King radio log.)

1445 hrs. On the east zone erratic and gusting winds (20 to 30 MPH with gusts up to 50 MPH) caused high fire activity in the northwest portion of the area east of Welcome Pass. In the late afternoon the fire heated up enough to create a firestorm condition (USDA Northern region, 1989).

1445 hrs. A decision was made to evacuate residents of Coopers Lake. The fire was 1.5 to 2 miles north of Coopers Lake and a mile north of the residents along the North Fork of the Blackfoot River (USDA Northern region, 1989).

1446 hrs. Benchmark RAWS unit records the temperature at 79F, relative humidity falling again at 13%, average wind speed at 11 MPH out of the south - southeast with gusts to 39 MPH from the north.

1457 hrs. The National Guard helicopter which was to drop off a fire crew from Lincoln Ranger District on Blowout Mountain reported it would be landing in about 5 minutes at Lincoln. The helicopter had developed difficulties and was returning without delivering its fire crew (Lincoln Ranger District radio log, Wilson interview). [Note; this turned out to be fortunate since the north slope of Blowout Mountain would be overrun by the Canyon Creek Fire later during the night.]

1500 hrs. DB 66, RH 23, wind 24 from the west - northwest, gusting into the 30's (Silver King Lookout Weather log.)

1500 hrs. Monture RAWS unit records the temperature steady at 85F, relative humidity continues to drop to 17%, average wind speed now 17 MPH from the south - southwest with gusts to 42 MPH from the south.

1500 hrs. Because of the worsening fire situation and the lack of accurate information regarding the exact location of the fire front the Lincoln District Ranger, Helena National Forest, Tom Liebscher, decided to remove trail crews which were working up the Middle Fork Creek of the East Fork of the Blackfoot River. Jerry Burns from the District volunteered to try and find the crew and get them out of the wilderness (Burns interview).

1518 hrs. Spotted Bear Lookout RAWS unit temperature starting to drop with the arrival of the cold front, 67F; relative humidity continues to drop with a reading of 17%, average wind speeds are 25 MPH from the south - southwest with gusts to 46 MPH from the southwest.

1530 hrs. "Get in touch with trail crew, have them head out." (Silver King radio log.)

1531 hrs. "Negative contact." (Silver King radio log.)

1533 hrs. "Halting retardant - wind." (Canyon Creek Fire, Lake Mountain Division Helibase log.)

1542 hrs. "All ships on ground." (Canyon Creek Fire, Lake Mountain Division Helibase log.)

1546 hrs. Benchmark RAWS unit records the temperature falling to 77F, relative humidity down to 11% (lowest RH reading for the day), average wind speed at 11 MPH out of the east - southeast with gusts to 39 MPH from the east. One Hr fuel moisture reaches their lowest reading of the day, 3%, and then begin to rise.

1600 hrs. "Socked in to west and north of Silver King. Dense smoke. Winds increasing, erratic, steady Mid 20's, gusting Low 30's." (Silver King radio log.)

1600 hrs. DB 67, RH 18, wind 26 from the west - northwest, gusts into the 30's (Silver King Lookout Weather log.)

1600 hrs. Monture RAWS unit records the temperature starting to fall at 84F, relative humidity drops sharply to 11%, average wind speed now 20 MPH from the south - southwest with gusts to 39 MPH from the south - southwest. The 1 Hr fuel moisture for this date reaches a low of 2% and will maintain that level for 3 hours before starting to again rise.

1618 hrs. Spotted Bear Lookout RAWS unit temperatures continue to decline sharply, 63F; relative humidity starting to rise with a reading of 21%, average wind speeds are 19 MPH from the south - southwest with gusts to 48 MPH from the southwest.

1646 hrs. Benchmark RAWS unit records the temperature falling to 75F, relative humidity steady at 11% (lowest RH reading for the day), average wind speed at 10 MPH out of the east with gusts to 38 MPH from the east - southeast. Ten Hr fuel moisture reaches their lowest reading of the day, 7%, and will remain at this level for 7 hours.

1700 hrs. DB 65, RH 22, wind 30 from the west - northwest, gusts into the high 30's (Silver King Lookout Weather log.)

1700 hrs. Monture RAWS unit records the temperature dropping slowly to 83F, relative humidity steady at 11%, average wind speed now 17 MPH from the south - southwest with gusts to 35 MPH from the south - southwest. Ten Hr fuel moisture reaches its lowest level for the day at 3% and will have a 6 hour period at this moisture level.

1718 hrs. Spotted Bear Lookout RAWS unit temperatures continue to decline sharply, 60F; relative humidity rises to 23%, average wind speeds are 20 MPH from the southwest with gusts to 37 MPH from the south - southwest.

1720 hrs. Jerry Burns took of from the Indian Meadows Work Center trailhead on horseback to locate the trail crew. The convection column that he could view from this location was quite large and covered most of the sky. It angled from the ground in the west, rising in a solid mass to the east. Winds on the ground were strong and moving down valley toward the convection column. The column was a dense, dark black as it rose beyond the intervening mountains. As the convection column rose it changed from the black to a dark gray. The fire itself was not visible. No radio contact had been made with the trail crew (Burns interview, Silver King Lookout radio log.)

1745 hrs. Trail crew radios the Silver King Lookout that they are taking their camp down and will be ready to packout. They radio that they are in "no immediate danger yet from fire." (Silver King Lookout radio log.)

1746 hrs. Benchmark RAWS unit records the temperature falling to 70F, relative humidity starting to rise, 14%; average wind speed at 7 MPH out of the east - northeast with gusts to 27 MPH from the east - southeast.

1800 hrs. DB 60, RH 19, wind 30 from the west - northwest, gusts high 30's (Silver King Lookout Weather log.)

1800 hrs. Monture RAWS unit records the temperature dropping to 80F, relative humidity steady for the third hour at 11%, average wind speed now 15 MPH from the south - southwest with gusts to 29 MPH from the south - southwest.

1800 hrs. Jerry Burns was on top of the Ringeye Creek Divide, a low drainage divide on the trail at the head of Copper Creek in the northeast corner of Section 19, T16N, R8W. From this point he could see the glow of the fire, which looked like it was running in the East Fork of the North Fork of the Blackfoot River. This was to the northeast and directly in his line of travel. The roaring from the fire was also quite loud at this point (Burns interview). Jerry passed two private individuals coming out of the wilderness at this location. (Lincoln Ranger District radio log.)

1805 hrs. Aerial observer reported fire at a point south of Bugle Mountain and on the ridge. The eastern extent of the fire was at a point between Meadow and Mineral Creeks. (Lincoln Ranger District radio log.)

1815 hrs. "Winds erratic, west / northwest steady 20, gusting low 30's. Visibility good to south of Silver King. Socked in due to dense smoke west / north / east." (Silver King radio log.)

1818 hrs. Spotted Bear Lookout RAWS unit temperatures continue to decline sharply, 56%; relative humidity rising rapidly with a reading of 29%, average wind speeds are 20 MPH from the south - southwest with gusts to 48 MPH from the west - southwest.

1826 hrs. "Fire coming down valley to Bear Lake." (Canyon Creek Fire, Lake Mountain Division Helibase log.)

1830 hrs. After reviewing the 1800 hrs radiosonde readings from Spokane, Washington the RICO Fire Behavior Service Center issued a special fire behavior warning to all dispatch offices and fire camps. A reverse wind profile was indicated which Byrum (1954) described as a low level jet and classified as a Type 2-b wind profile (figure 95). This type of wind profile is most likely during the night or late afternoon and is particularly dangerous on fires in rolling or mountainous terrain were the jet point may occur at the same elevation as the fire. Fire behavior with this type of profile is dominated by the wind, and for fires burning in heavy dry fuel could be very dangerous ahead of the fire. Indication from the radiosonde were that the jet point was at an elevation to interact with fires between 4,000 - 8,000 ft msl. It is likely that this wind profile was already having an initial effect on the Canyon Creek Fire when the profile was measured in Spokane.

The radiosonde from Great Falls for the same sample period showed a Type 4-a profile, a more normal wind profile, with strong winds. The lower elevations of the Great Falls radiosonde were being influenced by the presence of the mountains to the west with wind speeds increasing above the mountain's wind shadow effect with strong winds from the west (figure 96).

1835 hrs. "Fire (in Bear Creek) moving slowly. Winds going across valley near Cooper('s Lake). 1 1/4 mile from Cooper('s Lake)." (Canyon Creek Fire, Lake Mountain Division Helibase log.) [Note; This was a south flank of the main fire spread to the east.]

1840 hrs. At a brisk trot Jerry Burns and his horse passed the Webb Lake Guard Station and radioed a message to the Silver King Lookout to relay to the Lincoln Ranger District. He met the Foreman from the trail crew, Will Vigon, who was already headed out and packing bridging material and would be returning to the Indian Meadows Work Center tonight. Jerry would continue on and try to find the rest of the trail crew which had been camped on Middle Fork Creek above the junction with Landers Fork then return to Indian Meadows Work Center later that night. (Burns interview, Lincoln Ranger District radio log, Silver King Lookout radio log.)

1843 hrs. "Winds increasing, gusting low 30's." (Silver King radio log.)

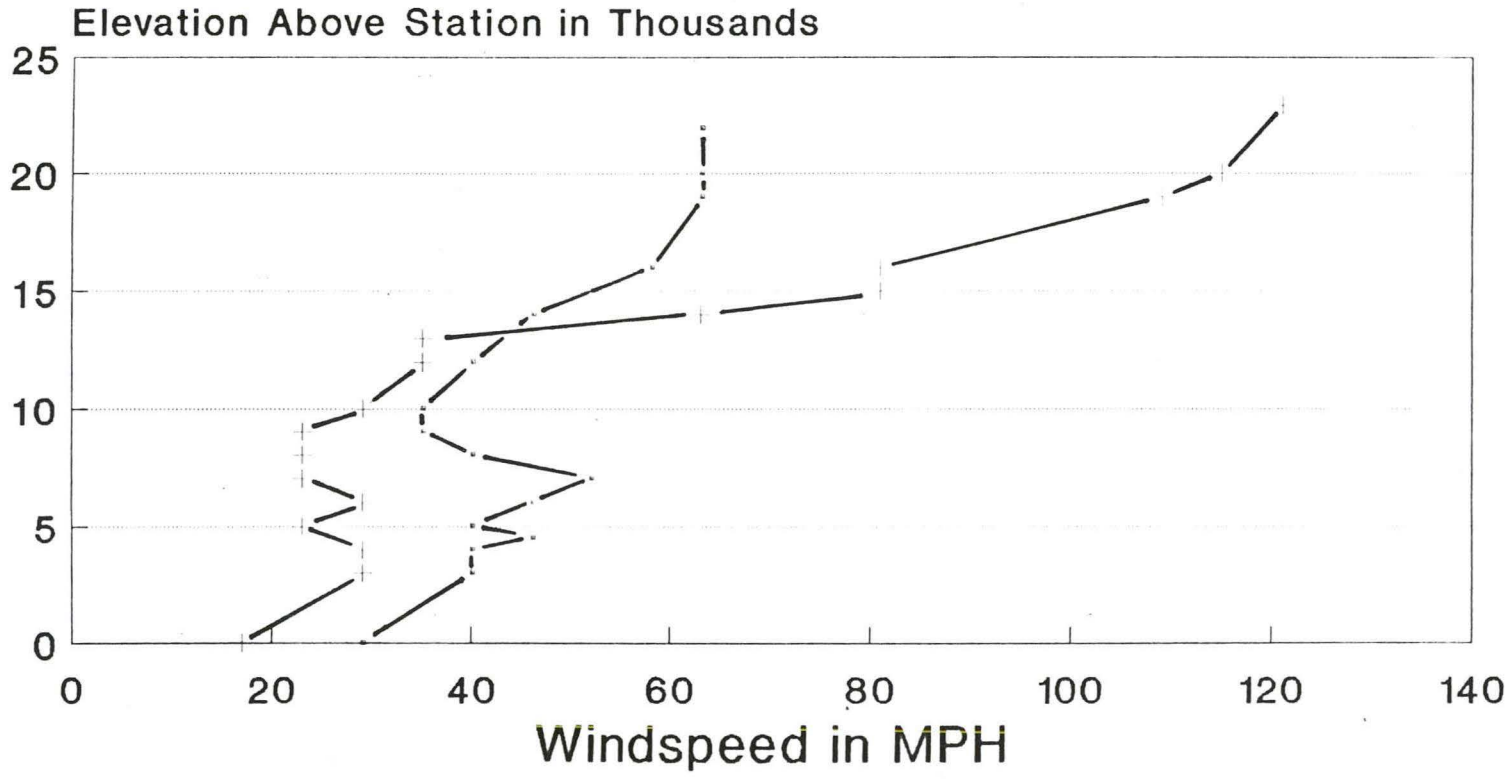
1845 hrs. Spot Fire Weather Forecast For the Canyon Creek Fire dry cold front passing through the region will keep the strong winds going tonight and into Wednesday. No precipitation at all with this system. Winds decreasing Wednesday afternoon, but still breezy. Red Flag Warning in effect tonight and Wednesday morning for strong westerly winds.

For Tonight...
Weather...smokey but few clouds
CWR...zero
Temperature...min temperatures near 40
Humidity...recovery slightly better, max 45-60%
Wind..eye level..west to northwest wind 10-20 MPH with gusts to 30 MPH across the ridges

For Wednesday...
Weather...a few high clouds, otherwise somewhat smokey
CWR...zero
Temperature...cooler, maxs 68-73
Humidity..min near 25%

Figure 95. Spokane International Airport radiosonde data for windspeed and elevation for the time periods of 1800 hrs September 6, 1988 and for 0600 hrs on September 7, 1988.

Spokane Radiosonde
Station Elevation 2357'



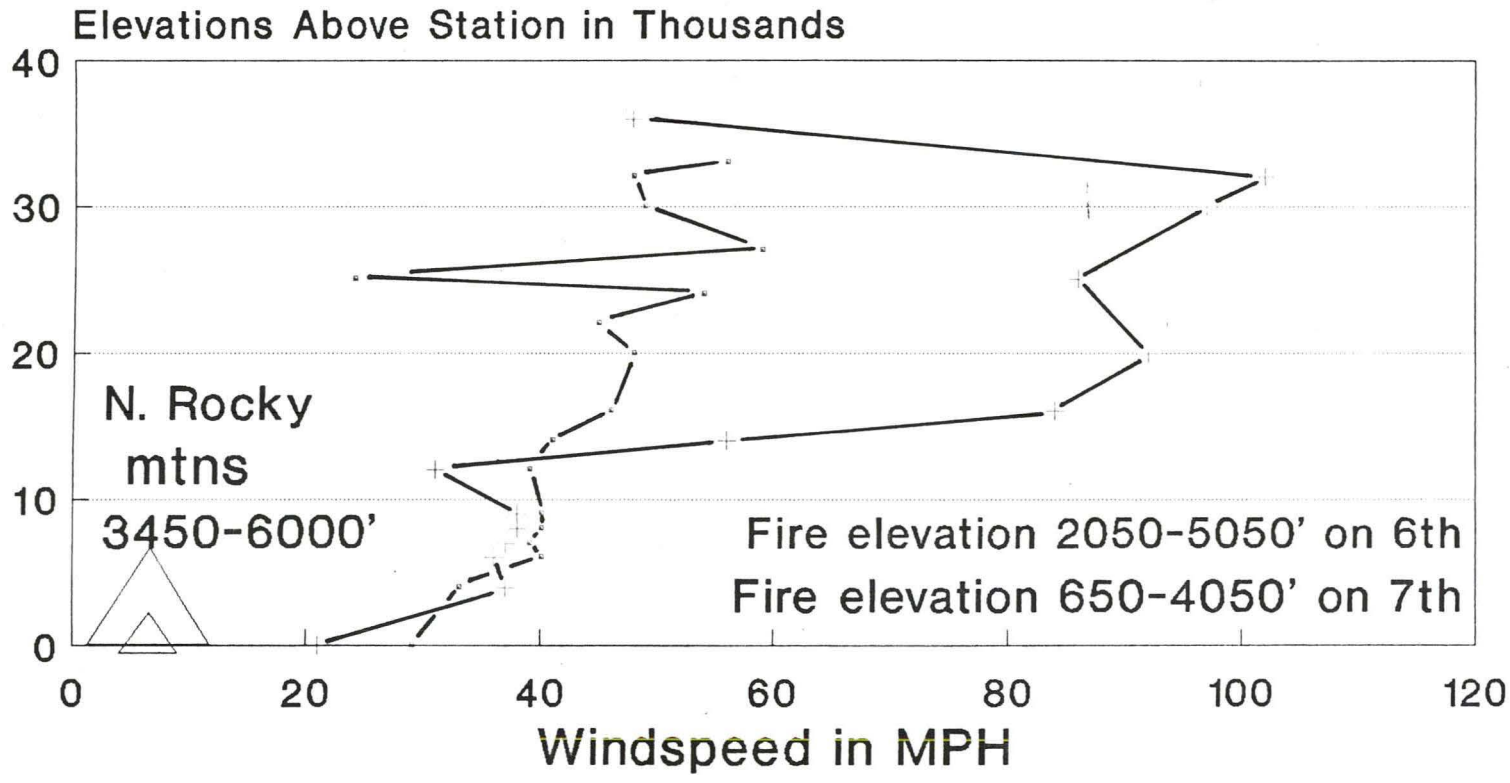
· Sept 6, 1800 hrs
Type 2-b Profile

+ Sept 7, 0600 hrs
Type 2-a Profile

Figure 96. Great Falls International Airport radiosonde data for windspeed and elevation for the time periods of 1800 hrs September 6, 1988 and for 0600 hrs on September 7, 1988.

Great Falls Radiosonde

Station Elevation 3751' msl



· Sept 6, 1800 hrs
Type 4-a Profile

+ Sept 7, 0600 hrs
Type 3-c Profile

Wind..eye level..west to northwest 10-15 MPH with gusts to 25 MPH across the ridges, decreasing slightly in late afternoon.

Outlook for Thursday...Mostly sunny. temperatures and humidity about the same. Winds westerly 8-12 MPH with gusts to 15 MPH. (Missoula Fire Weather Office)

1846 hrs. Benchmark RAWS unit records the temperature falling to 68F, relative humidity rising to 54%; average wind speed at 9 MPH out of the northeast with gusts to 38 MPH from the northeast.

1900 hrs. DB 60, RH 12, wind 30 from the west - northwest, gusts into the high 30's (Silver King Lookout Weather log.)

1900 hrs. Monture RAWS unit records the temperature falling more rapidly to 74F, relative humidity starting to rise to 13%, average wind speed now 5 MPH from the south - southwest with gusts to 21 MPH from the southeast.

1900 hrs. Jerry Burns arrived at the northeast corner of a lake at the head of the East Fork of the North Fork of the Blackfoot River. From this spot he could see the fire burning around the southwest flank of a hill in Section 6, T16N, R9W. The fire was quartering around the hill with the crown fire front involving what appeared to be the entire slope. The fire was moving toward Jerry but because of the heavy timber he could not tell how fast the fire was coming up the East Fork. The very loud roar and the sudden wind shift into the fire indicated the gravity of the situation (Burns interview).

1900 hrs. The fire was observed to cross to the east side of the North Fork of the Blackfoot River in the area of southeast Section 27. Explosive gases were causing the principal fire spread, with spotting up to 1/2 mile usually being overrun by the fire by the time they had grown to any size themselves. Strong up drainage winds were being sucked into the fire and were likely fire induced, these winds were having a strong influence on the southerly spread (May interview).

1910 hrs. Jerry Burns reached the trail junction at the mouth of the Landers Fork. The fire front which was visible was approximately on the Section line between Sections 9 and 10, or about 1/4 mile away to the west. The wind was being strongly drawn into the fire and was snapping the boles of 8-10" DBH lodgepole pine onto the trail around Jerry and his horse (Burns interview).

Because it was now evident that the fire would cut off the trail behind him, Jerry radioed the trail crew and had them head for Blacktail Pass and would meet them there, assuming he didn't get cut off by the fire, and then head down into the Dearborn River. (Burns interview, Silver King Lookout radio log.)

1918 hrs. Spotted Bear Lookout RAWS unit temperatures continue to decline, 55F; relative humidity climbs to 35%, average wind speeds are 22 MPH from the south - southwest with gusts to 43 MPH from the south - southeast.

1945 hrs. Jerry Burns reached the junction of the Middle Fork Creek and Landers Fork, meets the trail crew and starts up the Landers Fork toward Blacktail Pass. Because of the mountain ridge to their west they could not see the fire but they could hear the roar getting increasingly louder. Verbal communication

was impossible because of the noise made by the approaching fire. (Burns interview, Silver King Lookout radio log.)

1946 hrs. Benchmark RAWS unit records the temperature falling to 67F, relative humidity rising to 15%; average wind speed at 14 MPH out of the east - southeast with gusts to 57 MPH from the east - northeast.

1950 hrs. Burns and the trail crew had packed the camp on the horses and mules within five minutes and had traveled about 100 yards up the Landers Fork when the fire reached the ridgetop behind them. Burns estimated that the flame lengths were between 300-400' along a continuous wall of crown fire. Moving ahead of the fire over the tree canopy was a glowing gas ball. One of these gas balls traveled over the trail crews head and hit the opposite slope above them. The tree canopy exploded as if hit by napalm. With this route closed the crew turned around and headed back toward the drainage junction where they dropped the packs from the livestock and turned them loose except for riding stock. Burns figured their only chance to reach a safety zone was to make a dash for the talus slopes on top of Crow Mountain at the head of the Middle Fork Creek, a distance of over 3 miles, a climb of over 2300' with areas of slope to climb of 70%. Both slopes above and on either side of them were burning and "lots of firebrands the size of 1-2" pieces of logs, pine cones and branches" were dropping around them and onto Crow Creek Ridge to their left (Burns interview).

2000 hrs. Rapid fire spread reported along the south side of Elk Creek road and east into Harrison Basin toward Bean Lake.

2000 hrs. "Winds erratic, west / northwest upper 20's to lower 30's, gusting mid-upper 30's." (Silver King radio log.)

2000 hrs. DB 57, RH 12, wind 30 from the west - northwest, gusts to high 30's (Silver King Lookout Weather log.)

2000 hrs. Monture RAWS unit records the temperature falling to 72F, relative humidity climbs to 15%, average wind speed now 5 MPH from the southeast with gusts to 26 MPH from the west.

2005 hrs. "Extreme fire behavior - rapid!! 2000 ft MPH 25 MPH, 3000 ft 35 MPH, 4000 ft 40 MPH, 4500 ft 35 MPH, 6000 ft 40 MPH, 7000 ft 45 MPH, 8000 ft 35 MPH, 9000ft 30 MPH, 10000 ft 30 MPH." (Choteau Ranger Station Dispatch to Augusta Information Office, radio log.) [Note; elevation and wind speeds reference the 1800 hrs radiosonde readings from Spokane, Washington as sent by the RICO Fire Behavior Service Center with the indicated presence of a reverse wind profile.]

2018 hrs. Spotted Bear Lookout RAWS unit temperatures continue to decline, 53F; relative humidity climbs to 40%, average wind speeds are 19 MPH from the south - southwest with gusts to 54 MPH from the southwest.

2046 hrs. Benchmark RAWS unit records the temperature falling to 66F, relative humidity rising to 22%; average wind speed at 15 MPH out of the southeast with gusts to 47 MPH from the east.

2050 hrs. Burns and the trail crew were trapped in the bottom of Middle Fork Creek and were heading for the bottom of the talus slope of Crow Mountain. They radioed that there was "nothing we can do for now." Because of the steep terrain and darkness the progress was slow getting to the top. They lost the trail several times and one trail crew member was experiencing stomach distress. (Burns interview, Silver King Lookout radio log.)

2100 hrs. DB 55, RH 13, wind 30 from the west - northwest, gusts into high 30's (Silver King Lookout Weather log.)

2100 hrs. Monture RAWS unit records the temperature falling to 71F, relative humidity climbs to 17%, average wind speed now 6 MPH from the south with gusts to 26 MPH from the south. [Note; wind direction and speed at this station were apparently being strongly influenced and protected by the local terrain.]

2110 hrs. Burns and the trail crew made the rock slide, everyone's all right. Two of the three riding stock had run off in terror. Fire all around; Landers Creek, Mary Ann Creek and over Blacktail Pass. They will call back after finding a safer spot to spend the night. (Silver King Lookout, radio log.)

Jerry Burns and the two members of the trail crew climbed to the top of the ridge just south of Crow Mountain. They stayed in the rocks on the east slope and could see fire encircling them in all the surrounding drainages. Jerry periodically looked over the ridgetop into Cooney Creek basin to the west and which appeared to be completely on fire. The basin appeared to burn three different times with the light from these fires completely lighting up the area were the men were trapped. When looking over the ridge it was very difficult to stand in to the wind. The single mule which had also made it to the top of the mountain with the men ran from side to side of the rock slide looking for away out from the fires but eventually gave up and stood in terror. They wrapped up in horse blankets and spent a long, cold, windy night (Burns interview).

All the livestock were located two days later in an unburned area of the Middle Fork. The packs which they had discarded were found to be completely burned, leaving only the metal hardware from harnesses, etc. (Burns interview).

2115 hrs. "Glow behind mountains in Dearborn. No flames just glow." (Transmission from ground observer to the Augusta Information Station, radio log.)

2118 hrs. Spotted Bear Lookout RAWS unit temperatures continue to decline, 52F; relative humidity has risen to 44%, average wind speeds are 21 MPH from the south - southwest with gusts to 49 MPH from the southwest.

2121 hrs. "South of road by Greyns, 1 mile from road, grass fire." (Transmission from Caffee to the Augusta Information Station, radio log.)

2125 hrs. "(Fire) at end of road coming over ridge; east of Steamboat Mountain (Sections 19, 20, 21, T18N, R7W). Backside of Beaver Meadows. Winds northwest 15 MPH gusts to 30. Bean Lake stronger." (Transmission from ground observer to the Augusta Information Station, radio log.)

2130 hrs. The trail crew member who had made it back to the Indian Meadow Work Center reported a glow in the sky from Beaver Creek. (Lincoln Ranger District radio log.) [Note; no fire entered Beaver Creek, probably glow from fire on Bugle Mountain.]

2137 hrs. "(Fire) ridge from Beaver Meadows to head of Pole Gulch." Ground observer. (Augusta Information Station, radio log.)

2146 hrs. Benchmark RAWS unit records the temperature falling to 64F, relative humidity rising to 27%; average wind speed at 12 MPH out of the east - southeast with gusts to 30 MPH from the north - northwest (up drainage).

2155 hrs. "Reports fire burning to northeast between Windy Pass and Echo Pass. Looks like a fire on the other side of ridge (north of Cooper's Lake) has burned into our fire. Says he can see flames coming over backside of ridge." (General Message of a field observer to Canyon Creek Fire, Lake Mountain Division - Plans)

2200 hrs. DB 54, RH 19, wind 30 from the west - northwest, gusts into high 30's (Silver King Lookout Weather log.)

2200 hrs. Monture RAWS unit records the temperature falls to 69F, relative humidity climbs to 22%, average wind speed now 8 MPH from the south - southwest with gusts to 17 MPH from the south - southwest.

2218 hrs. Spotted Bear Lookout RAWS unit temperatures drops a single degree to 51F, relative humidity still increasing with a reading of 51%, average wind speeds are 20 MPH from the south - southwest with gusts to 45 MPH from the south - southeast.

2223 hrs. "(Fire) parallel to homes, down ridge to Bean Lake." (Transmission from ground observer to the Augusta Information Station, radio log.)

2225 hrs. "Winds west (at) Bean Lake. Low hill northwest of Bean Lake, spot fire ahead of main fire." (Transmission from ground observer to the Augusta Information Station, radio log.)

2225 hrs. "Three ranchers reported that the fire is just about to cross the road by Bean Lake." (Augusta Information Station, radio log.)

2246 hrs. Benchmark RAWS unit records the temperature falling to 63F, relative humidity rising to 30%; average wind speed at 13 MPH out of the east with gusts to 39 MPH from the east.

2250 hrs. "269 degrees - 358 degrees aglow." (Silver King radio log.)

2300 hrs. DB 54, RH 19, wind 30 from the west - northwest, gusts to the low 40's (Silver King Lookout Weather log.)

2300 hrs. Monture RAWS unit records the temperature falling to 67F, relative humidity climbs to 26%, average wind speed now 4 MPH from the south with gusts to 23 MPH from the south - southeast.

2318 hrs. Spotted Bear Lookout RAWS unit temperatures down to 50F, relative humidity still increasing with a reading of 55%, average wind speeds are 19 MPH from the south - southwest with gusts to 42 MPH from the south - southwest.

2346 hrs. Benchmark RAWS unit records the temperature falling to 62F, relative humidity rising to 34%; average wind speed at 10 MPH out of the east - southeast with gusts to 38 MPH from the east - southeast.

2350 hrs. "(Fire) Crossed route 434." Ground observer. (Augusta Information Station, radio log.)

2400 hrs. DB 50, RH 38, wind 34 from the west - northwest, gusts to the low 40's (Silver King Lookout Weather log.)

2400 hrs. Monture RAWS unit records the temperature falling to 66F, relative humidity climbs to 30%, average wind speed now 9 MPH from the south with gusts to 22 MPH from the south - southeast.

2400 hrs. County Route 434 closed north of Bean Lake and south of Augusta because of fire and heavy smoke (USDA Northern Region, 1989).

Great Falls NWS Weather Conditions:

1800 hrs. Sky Condition - Overcast, Visibility - 5 miles, smoke, Temperature - 84 degrees, Dew Point - 35, Wind - south-southwest 24 gusts to 34.

1900 hrs. Sky Condition - Overcast, Visibility - 4 miles, smoke, Temperature - 82 degrees, Dew Point - 34, Wind - south-southwest 18 gusts to 24.

2000 hrs. Sky Condition - Overcast, Visibility - 4 miles, smoke, Temperature - 80 degrees, Dew Point - 32, Wind - south-southwest 19 gusts to 24.

2100 hrs. Sky Condition - Overcast, Visibility - 4 miles, smoke, Temperature - 80 degrees, Dew Point - 32, Wind - south-southwest 19 gusts to 24.

2200 hrs. Sky Condition - Overcast, Visibility - 5 miles, smoke, Temperature - 79 degrees, Dew Point - 30, Wind - south-southwest 20 gusts to 27.

2300 hrs. Sky Condition - Overcast, Visibility - 7 miles, smoke, Temperature - 77 degrees, Dew Point - 28, Wind - south-southwest 18.

2400 hrs. Sky Condition - Overcast, Visibility - 5 miles, smoke, Temperature - 76 degrees, Dew Point - 28, Wind - south-southwest 20.

Regional Weather: Red Flag Warnings issued for this day in western Montana and northern Idaho, and the Greater Yellowstone area for winds associated with the frontal passage. Red Flag watch in eastern Montana was changed to a warning.

The strong, high pressure system had weakened and moved to the south. Skies remained mostly sunny, with smoke obscuring the sun and reducing visibility in western Montana. Visibility was reduced at times to 1/8 of a mile at West Yellowstone and down to 2 miles in the Livingston area. An examination of radiosonde stations between the Region and the US and Canadian west coast showed no indication of a low level reverse wind profile. Winds from stations near the front were indicating surface winds of 25 to 35 MPH.

Similar to other recent dry cold front passages. Lookout stations on the westside of the Kootenai National Forest reported morning (0800 hrs) winds of 30 to 35 MPH out of the southwest and calm conditions at lower elevations. Wind conditions were calm (1 - 5 MPH) on the Clearwater and Nez Perce National Forests. Free air winds at 0900 hrs at the Silver King Lookout south of the Canyon Creek Fire were 16 MPH from the west. Front position by 0900 hrs was from about Bonners Ferry-west of Grangeville. By 1000 hrs winds on the Clearwater and Nez Perce National Forests were between 2 to 12 MPH with gusts to 30 MPH. By 1200 hrs the front was on a line west of Kalispell-east of Grangeville. A surface low pressure trough developed about 1200 hrs on the east side of the Northern Rocky Mountains. Winds along the front were reported as 8 to 15 MPH with gusts to 30 MPH. As the front passed into the Northern Rocky Mountains it stalled and it became difficult to discern its exact location. Winds on the Clearwater National Forest peaked at 1300 hrs with 7 to 30 MPH winds gusting to 35 MPH and shifting from southwest to northwest. By 1400 hrs the winds on this Forest had started to decrease (7 - 20 MPH, gusts to 30 MPH). 1400 hrs winds on the Storm Creek Fire on the Custer National Forest were reported as 5 to 12 MPH with 22 MPH on the Ridgetops, and 8 to 10 MPH on the Dry Fork Fire in northwest Montana. Winds at the Silver King Lookout on the Helena National Forest about 1400 hrs indicated that the Canyon Creek Fire winds were increasing with 20 MPH gusts. A helibase log on the fire indicated 50 knot winds aloft. 1430 hrs winds were 20 MPH in West Yellowstone, and 8 to 10 MPH with gusts to 20 MPH on the Combination Fire (Deerlodge National Forest). At 1445 hrs light winds in Missoula became steady out of the south and southwest 12 to 20 MPH, gusts to 26 MPH then started to decline in speed. Surface winds on the Canyon Creek Fire gusted to 50 MPH, with 42 MPH gusts measured by the Monture RAWS. Winds at this RAWS unit had been averaging near 20 MPH since 1400 hrs. A strong low level reverse wind profile was indicated by the 1600 hr radiosonde reading from Spokane with winds out of the west-southwest. Visibility was reduced to 3/4 mile in Spokane by blowing dust and smoke as surface winds gusted to over 45 MPH. Downslope winds steadily increased along the Rocky Mountain front. By 1615 hrs Choteau reported winds steady at 36 to 42 MPH. The Beartop Lookout on the Gates Park Fire reported westerly winds at 20 MPH with gusts to 25. By 1700 hrs the front was on a line from about Malta-east of Bozeman-West Yellowstone. After 1700 hrs temperatures started to decrease in the vicinity of the Canyon Creek Fire. From 1700 hrs through 1900 hrs relative humidities on the west zone of this fire reached there lowest point of the day, 11%, as measured at the Monture RAWS and then started to recover. The RAWS station located at Benchmark on the east side of the fire also recorded its lowest relative humidity, 11% during the 1600-1700 hrs period. During the evening the Yellowstone area recorded winds up to 50 MPH on the Storm Fire and the Clover / Mist fire (Yellowstone National Park), 60 MPH gusts occurred on the higher peaks. Winds in the vicinity of the Clover / Mist fire abated shortly after midnight. Gusty winds over 30 MPH had occurred in most areas of the Region and over 40 MPH at some. Afternoon temperatures were similar to the two preceding days, in the mid-80's to low 90 degree range. Lewistown recorded the high temperature for Montana at 94 degrees (Bushey, 1989).

Long Range Forecast: The three to five day outlook was for cooler temperatures, higher humidities, and windy at times. Slight chance of showers would exist in northern areas of the Region. Six to ten day outlook called for temperatures to continue above normal and precipitation below normal (Bushey, 1989).

SEPTEMBER 7 (Julian Date 251)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 69.0
Seeley Lake Ranger Station; 3-day running mean ERC: 42.6
Gleason's Resort; 3-day running mean ERC: 62.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 5.6%
Gleason's Resort; 3-day running mean 10 Hr: 4.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.0%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 8-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 18-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 9-5%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 10-7%
Spotted Bear, 24 hr High-Low range, 1 Hr fuel: 13-2%
Spotted Bear, 24 hr High-Low range, 10 Hr fuel: 14-8%

BEHAVE Fuel Moisture:
(West Zone) 24 hr High-Low range, 1 Hr fuel: 9-5% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6-5%
24 hr High-Low range, 1 Hr fuel: 11-5% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6-5%
(East Zone) 24 hr High-Low range, 1 Hr fuel: 13-5% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 5%
24 hr High-Low range, 1 Hr fuel: 15-5% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6-5%

RAWS Fire Weather: Monture 24 hr temperature range: 49-68F
Monture 24 hr relative humidity range: 22-38%
Monture 24 hr average 20 ft wind speed range (MPH): 2-20
Monture 24 hr range of maximum wind gusts (MPH): 8-50
(Monture 1400 hrs readings; 63F, 24%, 20 MPH)
Benchmark 24 hr temperature range: 47-62F
Benchmark 24 hr relative humidity range: 26-48%
Benchmark 24 hr average 20 ft wind speed range (MPH): 2-14
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):9-47
(Benchmark 1546 hr readings (no 1346 hr); 62F, 26%, 11 MPH gusts to 47)
Spotted Bear LO 24 hr temperature range: 40-50F
Spotted Bear LO 24 hr relative humidity range: 44-62%
Spotted Bear LO 24 hr average 20 ft wind speed range (MPH): 16-31
Spotted Bear LO 24 hr range of maximum 20 ft wind gusts(MPH): 37-59

West Zone Fire Behavior: Areas within the interior of the fire runs from the previous night and early morning continued to burn out, however there was very little additional new spread under the influence of cooler afternoon temperatures and higher humidities.

The fire burned more today on the north slope of Red Mountain, west of Webb Lake, on Webb Lake Hill, near Two Point Lake, on Sheep Mountain and over the Continental Divide on the Lewis & Clark National Forest (Bonney, 1988).

Most of the fire between the Lake Mountain Timber Sale Area and Coopers Lake was relatively quiet by 0230 hrs even though the winds continued to blow out of the west. The strong winds prevented much flanking fire behavior and the main head of the fire run in this area had long since merged with the burned area near Mineral Creek and Bugle Mountain on the Helena National Forest. Later during the afternoon winds coming around the ridges developed cyclonic behavior on the North Fork of the Blackfoot River face in Section 34. As the column tipped across the river it started a spot 1/4 of the way upslope in Section 35. A prepared line along the section line to the base of the slope and then south along the base was ignited. An up canyon flow kept the fire within the line. During the day the fire moved several chains in McDermott Creek toward Coopers Lake. Peak afternoon burning conditions on the west side were; DB 65-75F, RH 25-30%, winds west to northwest 10-20, gusts to 30 (Carlson, 1988). Probability of Ignition during the afternoon burning period varied by elevation, with the low drainages areas ranging from 50 - 60% while higherr elevation sites were 40 - 50%.

East Zone Fire Behavior: The fire completed it's runs during the early morning hours and the strong winds carried ash in to the Great Falls airport approximately 53 miles east for five hours.

Continued burn out of interior areas lasted the rest of the day sending numerous convection columns into the air. Surface wind speeds declined allowing the columns to develop before being sheared off at higher elevations. However, this allowed the lower elevation smoke to clear out rapidly and visibility quickly improved.

Redmond Hot Shot crew OK, they walked out Elk trail to 6-Mountain Ranch. Had to watch out for falling snags because this was through the area just burned. Peila and rest of crews hiked out the Dearborn River trail to the Diamond Bar-X Ranch. Still very windy (Peila interview). Probability of Ignition for the East Zone peaked at 60% during the afternoon.

Digitized mapping of the newly burned acreage for the period of September 6th and 7th showed a total of 117,330 acres burned during the fire run. This brought the within perimeter fire acreage to 185,323 acres.

Satellite photograph of the Northern Rocky Mountains on this date clearly shows smoke from the Canyon Creek Fire tightly braided and still in a solid convection column approximately 300 miles downwind of the Scapegoat Wilderness. The configuation of the plume was indicative of strong winds near the surface, a low level jet stream (see satellite photo in Volume 1). A secondary frontal boundary was oriented on an east - west line across the fire, allowing the continuation of strong winds (Goens, 1990). Clouds in the photograph were north of the frontal boundary. A convection column emerging from the cloud pattern down toward the Canyon Creek Fire convection column was from the Red Bench Fire on the Flathead National forest and Glacier National Park, this fire also made a large sustained run during September 6th and 7th. Fires further south in the Selway - Bitterroot Wilderness and the region surrounding Yellowstone National Park showed the more typical fan-shaped smoke disperion pattern from large fires. These fires were being influenced by a strong westerly atmospheric flow pattern south of the dry cold front moving down from the north west with the jet stream along its leading edge.

0018 hrs. Spotted Bear Lookout RAWS unit temperatures drops a single degree to 49F, relative humidity stabilizes with a reading of 55%, average wind speeds are 23 MPH from the south - southwest with gusts to 59 MPH from the south.

0046 hrs. Benchmark RAWS unit records the temperature continuing to fall at 61F, relative humidity steady at 34%, average wind speed steady at 10 MPH out of the east - southeast with gusts to 27 MPH from the east.

0056 hrs. Radio report of the sky glowing from the Landers Creek and Red Mountain areas. (Lincoln Ranger District radio log.)
0100 hrs. DB 49, RH 47, wind 34 from the west - northwest, gusts in to the low 40's. (Silver King Lookout Weather log.)

0100 hrs. Monture RAWS unit records the temperature continues to fall reaching 65F, relative humidity climbs to 33%, average wind speed rises to 12 MPH from the south with gusts to 21 MPH from the south - southeast.

0100 hrs. "Highway 287 clear all way down. It's running parallel. 57-7 has not been crossed. Chism road 434 has been crossed." (Transmission from ground observer to the Augusta Information Station, radio log.)

0107 hrs. Jerry Burns reported that all of Landers Fork was on fire, fire had spread across to Lookout Creek Ridge to the northeast of Steamboat Mountain. East of the Continental Divide he couldn't see very much because of the smoke and darkness. (Silver King Lookout radio log.)

0118 hrs. Spotted Bear Lookout RAWS unit temperatures drops slightly to 47F, relative humidity still stable at 54%, average wind speeds are 31 MPH from the south - southwest with gusts to 55 MPH from the south - southwest.

0146 hrs. Benchmark RAWS unit records the temperature falling at 60F, relative humidity rising to 39%, average wind speed steady at 10 MPH out of the south - southeast with gusts to 31 MPH from the east - southeast.

0200 hrs. The fire advanced and all crews and overhead were moved out of the Elk Creek Camp. 15 left to protect the camp. Using a shower pump, they fought the fire on two fronts.

0200 hrs. Monture RAWS unit records the temperature continues to fall reaching 63F, relative humidity climbs to 35%, average wind speed at 7 MPH from the south - southwest with gusts to 30 MPH from the southwest.

0218 hrs. Spotted Bear Lookout RAWS unit temperatures drops a single degree to 46F, relative humidity rises sharply to 61%, average wind speeds are 27 MPH from the south - southwest with gusts to 51 MPH from the southwest.

0220 hrs. "Even through wind was strong, fire was still laid down." (Canyon Creek Fire, Lake Mountain Division radio log, transmission from ground observers.)

0246 hrs. Benchmark RAWS unit records the temperature falling at 58F, relative humidity falling slightly at 38%, average wind speed at 14 MPH out of the south with gusts to 29 MPH from the south.

0300 hrs. Monture RAWS unit records the temperature continues to fall reaching 62F, relative humidity climbs to 37%, average wind speed rises to 12 MPH from the southwest with gusts to 28 MPH from the south - southwest.

0300 hrs. The fire spread rapidly, driven by wind and producing heavy ground-level smoke (USDA Northern Region, 1989). [Note; this is in reference to the fires east of the Continental Divide.]

0300 hrs. Fire weather reported from the meadow safety zone north of Welcome Creek Guard Station was DB 75, RH 15%, winds west 40 MPH.

0310 hrs. "Fire still down showing little activity." (Canyon Creek Fire, Lake Mountain Division radio log.)

0318 hrs. Spotted Bear Lookout RAWS unit temperatures drops a single degree to 45F, relative humidity increasing with a reading of 61%, average wind speeds are 21 MPH from the south - southwest with gusts to 38 MPH from the west - southwest.

0346 hrs. Benchmark RAWS unit records the temperature continuing to fall at 56F, relative humidity falling at 37%, average wind speed at 13 MPH out of the south with gusts to 38 MPH from the south.

0400 hrs. Monture RAWS unit records the temperature steady at 62F, relative humidity drops to 33%, average wind speed rises to 19 MPH from the south - southwest with gusts to 37 MPH from the south - southeast.

0418 hrs. Spotted Bear Lookout RAWS unit temperatures drops to 43F, relative humidity increasing slightly with a reading of 62%, average wind speeds are 19 MPH from the south - southwest with gusts to 42 MPH from the south - southwest.

0446 hrs. Benchmark RAWS unit records the temperature continuing to fall at 54F, relative humidity rising slightly at 39%, average wind speed at 11 MPH out of the south - southeast with gusts to 32 MPH from the south. Ten Hr fuel moisture contents reached their maximum night time recovery of 10%. They would stay at this level for five hours before again declining.

0448 hrs. Jerry Burns and crew reported doing fine, no change in fire location from their position. Windy, 40+ MPH, and very smokey. (Lincoln Ranger District radio log.)

0500 hrs. Monture RAWS unit records the temperature continues to fall reaching 60F, relative humidity climbs slightly to 34%, average wind speed fallls to 14 MPH from the south - southwest with gusts to 26 MPH from the south.

0518 hrs. Spotted Bear Lookout RAWS unit temperatures drops to 40F, relative humidity increasing with a reading of 67%, average wind speeds are 22 MPH from the south - southwest with gusts dropping to 39 MPH from the west - southwest.

0546 hrs. Benchmark RAWS unit records the temperature continuing to fall at 53F, relative humidity rising to 41%, average wind speed at 14 MPH out of the southeast with gusts to 30 MPH from the south. The 1 Hr fuel moisture content reached its maximum moisture recovery of 9% during this reading.

0600 hrs. The radiosonde from Spokane, Washington indicated a Type 2-a reverse wind profile with the continued pressence of a low level jet point. This is one of the most dangerous wind profile types. The profile is of particular concern when the jet point occurs at or near the level of ongoing fires, a particular problem in mountainous terrain. Fire behavior characteristics for Type 2-a profiles may include fire whirls within convection columns contributing to spotting, long distance spotting, and towering convection columns (Byram, 1954). Wind speeds associated with the profile increased rapidly above about 15,000 ft msl (13,000 ft above the station), with speeds in excess of 120 MPH above 22,000 ft msl. These winds contributed to significant burn out fire behavior even with the higher relative humidities experienced behind the dry cold front. The radiosonde from Great Falls indicated a Type 3-c profile strongly influenced by mountainous terrain to the west. The Type 3-c profile has very high wind speeds at the jet point which then drop off with increasing elevation (reverse wind profile) for several thousand feet above the fire. Wind speeds in the upper elevations of the profile are also very high. Convection columns may sometimes build for short periods contributing to long distance spotting before being destroyed by the wind. A convection column though is not necessary for fires under the influence of this wind profile to rapidly spread driven by the wind (Byram, 1954). However, by this time the Canyon Creek Fire had been surrounded by a well established blackline of burned grassland and the burn out of heavier forest fuel within the interior failed to contribute to additional perimeter spread.

0600 hrs. Silver King Lookout reports west / northwest winds 20-24 MPH with gusts to 30. (Lincoln Ranger District radio log.)

0600 hrs. Monture RAWS unit records the temperature continues to fall reaching 58F, relative humidity resumes falling to 33%, average wind speed steady at 14 MPH from the south - southwest with gusts to 25 MPH from the southwest.

0618 hrs. Spotted Bear Lookout RAWS unit temperatures rises for the first time in 16 hours to 42F, relative humidity drops slightly for the first time also in 16 hours with a reading of 63%, average wind speeds are 21 MPH from the south - southwest with gusts to 41 MPH from the southwest.

0630 hrs. "Winds west / northwest steady 20 MPH, gusting to low 30's." (Silver King radio log.)

0630 hrs. "Fire on south side of Steamboat (Mountain) way up on mountain. smoke to southeast." (Transmission from ground observer to the Augusta Information Station, radio log.)

When the smoke cleared the camp and most structures were intact. The fire moved several miles onto the prairie, but was still 5 miles from Augusta. The combination of high winds, high temperatures, low humidities and super-dry fuels produced fire expansion on several fronts. More than 180,000 acres were consumed in one burning period. Some 30000 to 40000 + acres of private, state and BLM lands (USDA Northern Region, 1989). [Note; the 180,000 acres was an estimate at the time, as mentioned above the burned acreage for the two day period of September 6th and 7th was digitized at 117,330 acres.]

0646 hrs. Benchmark RAWS unit records the temperature rising at 54, relative humidity falling at 40%, average wind speed at 13 MPH out of the south with gusts to 34 MPH from the southeast.

0700 hrs. DB 44, RH 36, wind 20 from the west - northwest, gusts in to the low 30's (Silver King Lookout Weather log.)

0700 hrs. Monture RAWS unit records the temperature continues to fall reaching 56F, relative humidity falls 32%, average wind speed at 9 MPH from the south with gusts to 20 MPH from the south.

0718 hrs. Spotted Bear Lookout RAWS unit temperatures drops a single degree to 41F but has essentially stablized, relative humidity increasing a single percentage point to 64%, average wind speeds are 20 MPH from the south - southwest with gusts to 40 MPH from the southwest.

0746 hrs. Benchmark RAWS unit records the temperature rising at 55F, relative humidity falling at 37%, average wind speed at 9 MPH out of the south - southeast with gusts to 34 MPH from the southeast.

0800 hrs. DB 44, RH 48, wind 20 from the west - northwest, gusts in to the low 30's (Silver King Lookout Weather log.)

0800 hrs. Monture RAWS unit records the temperature steady at 56F, relative humidity climbs back up to 33%, average wind speed rises to 10 MPH from the south - southwest with gusts to 30 MPH from the south.

0810 hrs. Jerry Burns reports that visibility from the top of Crow Mountain is about 5 miles. (Silver King Lookout radio log.)

0818 hrs. Spotted Bear Lookout RAWS unit temperatures rising again to 43F, relative humidity continuing to drop to 60%, average wind speeds are 21 MPH from the southwest with gusts to 37 MPH from the southwest.

0821 hrs. Helicopter setting down 1 mile south of Crow Mountain to pickup trail crew. (Lincoln Ranger District radio log.)

The wind was estimated to be blowing 40-50 MPH out of the west at the helicopter landing site (Bonney narrative).

0830 hrs. Helicopter reports it has lifted off with Jerry Burns and the trail crew from Crow Mountain. (Lincoln Ranger District radio log.)

0846 hrs. Benchmark RAWS unit records the temperature rising at 57F, relative humidity falling at 35%, average wind speed at 10 MPH out of the south - southeast with gusts to 39 MPH from the south - southeast.

0900 hrs. The fire was about 1 mile north of Cooper's Lake holding on an east/west line up to Echo Mountain (USDA Northern Region, 1989).

0900 hrs. DB 43, RH 47, wind 20 from the west - northwest, gusts in to the low 30's (Silver King Lookout Weather log.)

0900 hrs. Monture RAWS unit records the temperature climbs to 57F, relative humidity steady at 33%, average wind speed rises to 12 MPH from the south - southwest with gusts to 29 MPH from the south - southwest.

0918 hrs. Spotted Bear Lookout RAWS unit temperatures climb to 41F, relative humidity drops to 57%, average wind speeds are 19 MPH from the south - southwest with gusts to 40 MPH from the southwest.

0946 hrs. Benchmark RAWS unit records the temperature rising at 58F, relative humidity falling at 32%, average wind speed at 13 MPH out of the east - southeast with gusts to 31 MPH from the east.

1000 hrs. DB 46, RH 37 (Silver King Lookout Weather log.)

1000 hrs. Monture RAWS unit records the temperature climbs to 59F, relative humidity starting to drop again to 31%, average wind speed at 10 MPH from the southwest with gusts to 32 MPH from the west.

1018 hrs. Spotted Bear Lookout RAWS unit temperatures climb to 48F, relative humidity drops to 49%, average wind speeds are 21 MPH from the south - southwest with gusts to 41 MPH from the southwest.

1046 hrs. Benchmark RAWS unit records the temperature rising at 59F, relative humidity falling at 30%, average wind speed at 14 MPH out of the east - southeast with gusts to 32 MPH from the east - southeast. One Hr fuel moisture reaches the lowest measurement for the day, 5%, and will remain at this level for seven hours.

1100 hrs. DB 47, RH 34 (Silver King Lookout Weather log.)

1100 hrs. Monture RAWS unit records the temperature rises to 60F, relative humidity drops to 28%, average wind speed rises to 14 MPH from the south - southwest with gusts to 50 MPH from the south.

1114 hrs. Silver King Lookout reported "out of service," and a huge convection column north of the lookout, not much to the west and northwest. (Lincoln Ranger District radio log.)

1115 hrs. Aerial observer over the head of Beaver Creek reports that south and east of Caribou Peak "is really cooking, heading north, will go around north end of Scapegoat Mountain and then to Helena." (Lincoln Ranger District radio log.) [Note; he probably meant Blowout Mountain, not Scapegoat Mountain.]

1118 hrs. Spotted Bear Lookout RAWS unit temperatures climb to 49F, relative humidity drops to 46%, average wind speeds are 20 MPH from the south - southwest with gusts to 42 MPH from the south - southwest.

1138 hrs. Convection column reported by an aerial observer who was headed for Helena over Webb Lake was 15-20,000 ft out of Lake Creek. (Lincoln Ranger District radio log.)

1146 hrs. Gap in the data collection from the Benchmark RAWS unit.

1200 hrs. DB 49, RH 47 (Silver King Lookout Weather log.)
Silver King Lookout evacuated after 50 days of service. Evacuation was a safety precaution because of the fear the fire could possibly turn south. Eventually John Wilson the lookout returned. (Silver King Lookout radio log, Wilson interview)

1200 hrs. Monture RAWS unit records the temperature rises to 63F, relative humidity drops to 24%, average wind speed rises to 20 MPH from the south - southwest with gusts to 40 MPH from the south - southwest.

1200 hrs. Smoke was dense, but the fire in the prairie appeared out (USDA Northern Region, 1989).

1218 hrs. Spotted Bear Lookout RAWS unit temperatures drop a few degrees to 47F, relative humidity climbs slightly to 48%, average wind speeds are 21 MPH from the southwest with gusts to 37 MPH from the south - southwest.

1246 hrs. Gap in the data collection from the Benchmark RAWS unit.

1300 hrs. Monture RAWS unit records the temperature rises to 67F, relative humidity drops to 22%, average wind speed at 19 MPH from the south - southwest with gusts to 36 MPH from the southwest.

1318 hrs. Spotted Bear Lookout RAWS unit temperatures stays at 47F, relative humidity climbs to 49%, average wind speeds are 21 MPH from the south - southwest with gusts to 42 MPH from the southwest.

1335 hrs. Fire had not crossed Highway 200, closest point the fire had reached to the highway was in Section 25, T17N, R7W. Black smoke crossing Highway 200 at Section House. Winds are from the west. (Lincoln RD radio log.)

1346 hrs. Gap in the data collection form the Benchmark RAWS unit.

1400 hrs. Monture RAWS unit records the temperature drops to 66F, relative humidity steady at 22%, average wind speed drops to 8 MPH from the west - southwest with gusts to 40 MPH from the south - southwest.

1418 hrs. Spotted Bear Lookout RAWS unit temperatures climb to 48F, relative humidity drops to 44%, average wind speeds are 19 MPH from the south - southwest with gusts to 37 MPH from the south - southwest.

1446 hrs. Benchmark RAWS unit records the temperature as has risen to 62F (this would be the high temperature reading for the day at this station), relative humidity dropping to 26% (low RH reading for the day), average wind speed at 11 MPH out of the south - southeast with gusts to 47 MPH from the south - southwest.

1500 hrs. Monture RAWS unit records the temperature rises to 68F, relative humidity steady at 22%, average wind speed at 13 MPH from the west - southwest with gusts to 36 MPH from the south - southwest. One Hr fuel moisture reaches the low for the day at 3% and will remain at this level for 4 hours.

1510 hrs. Aerial observer reports fire is close to Webb Lake on a northeast line up the ridge from there. Smoke is very heavy, hard to see. (Lincoln Ranger District radio log.)

1518 hrs. Spotted Bear Lookout RAWS unit temperatures starting to drop down to 46F, relative humidity climbing to 50%, average wind speeds are 20 MPH from the south - southwest with gusts to 40 MPH from the south - southwest.

1535 hrs. Aerial observe reports no smoke in Landers Fork up to a point opposite Heart Lake, fire very close to Webb Lake. Fire in upper Landers Fork, 1/2 mile north of Heart Lake. (Lincoln Ranger District radio log.)

1546 hrs. Benchmark RAWS unit records the temperature starting to decline at 60F, relative humidity starting to climb at 29%, average wind speed at 9 MPH out of the south - southeast with gusts to 34 MPH from the south. Ten Hr fuel moisture content achieve their lowest reading for the day, 7%, which was maintained for two hours.

1600 hrs. Monture RAWS unit records the temperature starts to fall to 67F, relative humidity starting to rise at 23%, average wind speed is declining at 12 MPH from the west - southwest with gusts to 30 MPH from the south. Ten Hr fuel moistures reach their low for the day at 4% and will remain at this level for 6 hours.

1618 hrs. Spotted Bear Lookout RAWS unit temperatures stays at 46F, relative humidity drops to 47%, average wind speeds are 19 MPH from the south - southwest with gusts to 44 MPH from the south - southwest.

1630 hrs. Byon Bonney reports from upper Beaver Creek road that the fire could be going to the ridge toward Daly Peak. It is behind the mountain just south of Arrastra Mountain and maybe a drainage over. (Lincoln Ranger District radio log.) [Note; no fire occurred on Arrastra Mountain area, probably seeing continued burnout in Mineral Creek and Bugle Mountain areas.]

1646 hrs. Benchmark RAWS unit records the temperature falling at 57F, relative humidity rising at 32%, average wind speed at 11 MPH out of the south - southeast with gusts to 38 MPH from the south - southeast.

1700 hrs. Monture RAWS unit records the temperature steady at 67F, relative humidity rising at 24%, average wind speed at 11 MPH from the southwest with gusts to 32 MPH from the south.

1718 hrs. Spotted Bear Lookout RAWS unit temperatures down to 44F, relative humidity climbing to 50%, average wind speeds are 20 MPH from the south - southwest with gusts to 52 MPH from the south - southwest.

1746 hrs. Benchmark RAWS unit records the temperature falling at 54F, relative humidity rising at 35%, average wind speed at 10 MPH out of the south with gusts to 29 MPH from the southeast.

1800 hrs. Monture RAWS unit records the temperature drops to 65F, relative humidity rises to 25%, average wind speed at 7 MPH from the west - southwest with gusts to 24 MPH from the west - southwest.

1818 hrs. Spotted Bear Lookout RAWS unit temperatures stays at 44F, relative humidity climbs to 55%, average wind speeds are 22 MPH from the southwest with gusts to 56 MPH from the southwest.

1846 hrs. Benchmark RAWS unit records the temperature falling at 52F, relative humidity rising at 37%, average wind speed at 6 MPH out of the southeast with gusts to 30 MPH from the southwest.

1900 hrs. Monture RAWS unit records the temperature down to 59F, relative humidity rising at 29%, average wind speed at 6 MPH from the east with gusts to 10 MPH from the west - southwest.

1918 hrs. Spotted Bear Lookout RAWS unit temperatures drops to 43F, relative humidity drops to 54%, average wind speeds are 22 MPH from the south - southwest with gusts to 42 MPH from the southwest.

1946 hrs. Benchmark RAWS unit records the temperature falling at 52F, relative humidity dropping to 33%, average wind speed at 1 MPH out of the south with gusts to 20 MPH from the south.

2000 hrs. Monture RAWS unit records the temperature falls to 57F, relative humidity rises to 30%, average wind speed at 5 MPH from the northwest with gusts to 16 MPH from the west - northwest.

2018 hrs. Spotted Bear Lookout RAWS unit temperatures stays at 43F, relative humidity climbs to 55%, average wind speeds are 22 MPH from the south - southwest with gusts to 37 MPH from the southwest.

2030 hrs. "Fire on ridge has dropped on Petty Creek side." Ground observer. (Augusta Information Station, radio log.)

2046 hrs. Benchmark RAWS unit records the temperature falling at 48F, relative humidity rising again at 44%, average wind speed at 4 MPH out of the south - southeast with gusts to 12 MPH from the south - southeast.

2100 hrs. Monture RAWS unit records the temperature falls to 55F, relative humidity rises to 32%, average wind speed at 5 MPH from the south - southwest with gusts to 8 MPH from the southwest.

2118 hrs. Spotted Bear Lookout RAWS unit temperatures drop to 42F, relative humidity climbs to 58%, average wind speeds are 20 MPH from the south - southwest with gusts to 40 MPH from the southwest. wind speeds are starting to decline.

2146 hrs. Benchmark RAWS unit records the temperature falling at 47F, relative humidity rising at 48%, average wind speed at 2 MPH out of the south - southeast with gusts to 9 MPH from the south - southeast.

2200 hrs. Monture RAWS unit records the temperature falls to 49F, relative humidity rises to 38%, average wind speed at 3 MPH from the west - southwest with gusts to 8 MPH from the southwest.

2218 hrs. Spotted Bear Lookout RAWS unit temperatures drop to 41F, relative humidity climbing to 62%, average wind speeds are 16 MPH from the southwest with gusts to 33 MPH from the west - southwest. This was the first hour that the average wind speeds had dropped below 19 MPH in the last 34 hours at this atation.

2246 hrs. Benchmark RAWS unit records the temperature rising to 50F, relative humidity falling at 44%, average wind speed at 4 MPH out of the east with gusts to 17 MPH from the west - southwest.

2300 hrs. Monture RAWS unit records the temperature falls to 47F, relative humidity rises to 42%, average wind speed at 2 MPH from the south - southwest with gusts to 8 MPH from the southwest.

2318 hrs. Spotted Bear Lookout RAWS unit temperatures stays at 41F, relative humidity climbing to 64%, average wind speeds are 18 MPH from the southwest with gusts to 31 MPH from the south - southwest.

2346 hrs. Benchmark RAWS unit records the temperature falling at 46F, relative humidity rising at 51%, average wind speed at 5 MPH out of the west - northwest with gusts to 12 MPH from the east - northeast.

Great Falls NWS Weather Conditions:

0100 hrs. Sky Condition - Overcast, Visibility - 4 miles, smoke, Temperature - 74 degrees, Dew Point - 27, Wind - south-southwest 16.

0200 hrs. Sky Condition - Overcast, Visibility - 5 miles, smoke, Temperature - 73 degrees, Dew Point - 30, Wind - south-southwest 18 gusts to 22, Falling Ash.

0300 hrs. Sky Condition - Overcast, Visibility - 5 miles, smoke, Temperature - 72 degrees, Dew Point - 33, Wind - south-southwest 16 gusts to 23, Falling Ash.

0300 hrs. Sky Condition - Overcast, Visibility - 5 miles, smoke, Temperature - 70 degrees, Dew Point - 35, Wind - south-southwest 17 gusts to 22, Falling Ash.

0400 hrs. Sky Condition - Overcast, Visibility - 6 miles, smoke, Temperature - 68 degrees, Dew Point - 34, Wind - south-southwest 18, Falling Ash.

0500 hrs. Sky Condition - Broken, Visibility - 7 miles, smoke, Temperature - 66 degrees, Dew Point - 34, Wind - south-southwest 18, Falling Ash.

0600 hrs. Sky Condition - Broken, visibility - 8 miles, smoke, Temperature - 65 degrees, Dew Point - 35, Wind - south-southwest 20 gusts to 25.

0700 hrs. Sky Condition - Scattered, visibility - 6 miles, smoke, Temperature - 62 degrees, Dew Point - 35, Wind - south-southwest 14, Pressure Rising.

0800 hrs. Sky Condition - Broken, visibility - 15 miles, Temperature - 64 degrees, Dew Point - 30, Wind - south-southwest 22 gusts to 25.

0900 hrs. Sky Condition - Scattered, visibility - 15 miles, Temperature - 65 degrees, Dew Point - 29, Wind - south-southwest 25 gusts to 38.

1000 hrs. Sky Condition - Scattered, visibility - 15 miles, Temperature - 67 degrees, Dew Point - 29, Wind - south-southwest 27 gusts to 32.

1100 hrs. Sky Condition - Scattered, visibility - 20 miles, Temperature - 68 degrees, Dew Point - 27, Wind - south-southwest 26 gusts to 30.

1200 hrs. Sky Condition - Scattered, visibility - 20 miles, Temperature - 70 degrees, Dew Point - 27, Wind - south-southwest 18 gusts to 30.

1300 hrs. Sky Condition - Scattered, visibility - 15 miles, Temperature - 71 degrees, Dew Point - 26, Wind - south-southwest 22 gusts to 32.

1400 hrs. Sky Condition - Scattered, visibility - 15 miles, Temperature - 72 degrees, Dew Point - 25, Wind - south-southwest 24 gusts to 33.

1500 hrs. Sky Condition - Scattered, visibility - 15 miles, Temperature - 73 degrees, Dew Point - 25, Wind - south-southwest 22 gusts to 29.

1600 hrs. Sky Condition - Scattered, visibility - 15 miles, Temperature - 72 degrees, Dew Point - 24, Wind - south-southwest 22 gusts to 30.

1700 hrs. Sky Condition - Overcast, visibility - 15 miles, Temperature - 73 degrees, Dew Point - 25, Wind - south-southwest 19 gusts to 29.

Weather Forecast: Brisk westerly wind flow over area today and Thursday with cooler airmass.

For Today...
Weather...partly cloudy, few sprinkles
CWR...zero
Temperature...from 75 bottoms to 60s high elevations
Humidity...25 to 35%
Wind..eye level..westerly 8 to 16, 20 to 35 at times ridges and westerly exposed slopes. Winds erratic northeast to southeast exposures.

For Tonight...
Weather...clear to partly cloudy, smokey bottoms
CWR...zero
Temperature...mins from 38 bottoms to 28 top bottom
Humidity...max 70s bottoms and 50% slopes/ridges
Wind..eye level..variable 2 to 8 with wesat to northwest 10 to 20 gusty ridges. Upper elevation west to northwest exposed slopes.

Outlook for Thursday...Partly cloudy, smokey in bottoms in morning. Temperatures little change. Humidity min 20s and 30s. winds variable 3 to 8 with 10 to 20 upper slopes and ridges. (Missoula Fire Weather Office Spot Fire Forecast for Canyon Creek Fire; Lake Creek and the Elk Creek Divisions, 0850 hrs. Wednesday September 7, 1988)

Weather Forecast: A weak high pressure system will move through the area during the next few days. The strong winds in the area will decrease as this system moves in. The weekend will see a change as a strong low moves south from alaska to bring a chance of showers, cooler temperatures and higher humidity.

For Tonight...
Weather...clearing
CWR...zero
Temperature...cooler, min 35-40
Humidity...recovery better, max 60-70%
Wind..eye level..westerly 8-12 MPH with gusts to 20. Decreasing late tonight

For Thursday...
Weather...sunny
CWR...zero
Temperature...afternoon highs 65-70
Humidity...afternoon mins near 20%
Wind..eye level..westerly 8-12 MPH and gusting to 20 MPH. Decreasing.

Outlook for Friday...Mostly sunny. temperatures and humidity about the same. Winds westerly ridges 5-10 MPH, otherwise terrain driven. (Missoula Fire Weather Office Spot Fire Forecast for Canyon Creek Fire, 1835 hrs. Wednesday September 7, 1988)

Regional Weather: Red Flag Warnings remained in effect for eastern Montana, particularly the southern portions and the Greater Yellowstone area for gusty winds and low humidities.

Winds continuing throughout the night and kept temperatures in the 50's and low 60's across most of the Region as a dry cold front passed through Montana from the northwest during the early morning hours. At 0300 hrs on the Canyon Creek Fire in the meadow were 110 persons were safely watching the fire a temperature of 75 degrees, 15% relative humidity, and 40 MPH westerly winds were reported. Skies across the Region were generally partly cloudy to mostly sunny. Smoke from the forest fires reduced visibility across the southern and western portions of the Region. Several stations reported visibility of 2 miles or less during the morning, but with improvement by the afternoon. Inversions in the Yellowstone area lifted in the late morning. The 0600 hrs Spokane radiosonde still indicated a strong low level reverse wind profile with upper level winds over 15,000' being between 70 and 105 MPH. The only rainfall experienced were a few sprinkles across the hi-line and north into Canada. Glasgow reported .04" of rain. By 1200 hrs the cold front had exited from the Region. Afternoon temperatures were mostly in the 70's behind the front. Twenty to 40 MPH west winds were common with Glasgow reporting the strongest gusts at 48 MPH and Great Falls reaching gust to 44 MPH. Afternoon and evening winds in the Yellowstone area blew from the southwest to west at 15 to 30 MPH. Gusts to 40 to 50 MPH were reported on the Storm and Clover / Mist Fires. High temperatures in these areas ranged from 75 to 85 degrees, and low humidities ranged from 8 to 18% (Bushey, 1989).

SEPTEMBER 8 (Julian Date 252)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 68.0
Seeley Lake Ranger Station; 3-day running mean ERC: 42.0
Gleason's Resort; 3-day running mean ERC: 63.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 6.0%
Gleason's Resort; 3-day running mean 10 Hr: 4.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.3%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 13-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 19-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 21-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 19-8%
Spotted Bear, 24 hr High-Low range, 1 Hr fuel: 15-5%
Spotted Bear, 24 hr High-Low range, 10 Hr fuel: 16-9%

BEHAVE Fuel Moisture:
(West Zone) 24 hr High-Low range, 1 Hr fuel: 13-6% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 6%
24 hr High-Low range, 1 Hr fuel: 15-6% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 7-6%
(East Zone) 24 hr High-Low range, 1 Hr fuel: 9-6% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 7-6%
24 hr High-Low range, 1 Hr fuel: 11-7% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 9-7%

RAWS Fire Weather: Monture 24 hr temperature range: 39-75F
Monture 24 hr relative humidity range: 19-53%
Monture 24 hr average 20 ft wind speed range (MPH): 1-12
Monture 24 hr range of maximum wind gusts (MPH): 3-25
(Monture 1400 hrs readings; 67F, 25%, 11 MPH)
Benchmark 24 hr temperature range: 33-68F
Benchmark 24 hr relative humidity range: 21-80%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-13
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):6-37
(Benchmark 1346 hr readings; 68F, 21%, 9 MPH gusts to 24)

West Zone Fire Behavior: In the west zone, cooler temperatures and light winds calmed the fire. No major runs today. Some fire found in the very head end of Falls Creek on the west side of the divide. Only about 5-10 acres (Bonney, 1988).

At 0300 a line was constructed from Bear Lake down to Bear Creek which tied into a previously constructed line. A burnout was attempted but was discontinued immediately when it became apparent that the high humidity would prevent a successful burn. The 10 hr and 100 hr fuel components were not present in sufficient quantities to make up for the estimated 13% 1hr fuel moistures at 0300. A natural barrier prevented fire from moving further south in along the Blackfoot on the east side and a control line stopped the spread on the west side. At 1600 another burnout was attempted and discontinued after it became apparent it would not carry (Carlson, 1988). Afternoon extreme burning conditons ranged from; DB early AM 40F, PM 65-75F; RH early AM 70%, PM 25-30%; wind northwest to west 5-10 (Carlson, 1988). Afternoon burning conditions only allowed the Probability of Ignition on this day to range from 40 - 50%.

0830 hrs. DB 51, WB 43, RH 56, wind southeast 0-3 MPH. (Fire Camp Plans Tent, Fire Weather Observer notes, Lake Mountain Division.)

1717 hrs. "Burnout will not work on Bear Creek by Bear lake..." (Canyon Creek Fire, Lake Mountain Division radio log.)

East Zone Fire Behavior: The most active burning continued in Petty Creek, south of the Benchmark road and south of the Dearborn River area, near Blowout Mountain. At Blowout Mountain, fire was hottest along Falls Creek Ridge. Retartant drops were made all day. The fire did not make any major runs. Probability of Ignition during the afternoon also only rose to between 40 - 50% in the East Zone.

Weather Forecast: High pressure at the surface and lighter wind flow pattern today. Airmass still very dry. High pressure holding Friday.

For This Afternoon...
Weather...mostly clear
CWR...zero
Temperature...max 72 at 4500 ft to 60 at 7500 ft
Humidity...Min 15%
Wind..eye level..variable 2 to 6 MPH. Afternoon winds west 15 gusty through passes and on upper slopes and ridges.

For Tonight...
Weather...clear and cool and smokey
CWR...zero
Temperature...min temperatures 30s
Humidity...Max 75 bottoms, 35 to 50% slopes/ridges
Wind..eye level..variable 0 to 6 MPH, occasional west to northwest 10 upper slopes/ridges

Outlook for Friday...Slightly warmer and drier, light winds with southeast to southwest 10 to 15 at times exposed areas afternoon. (Missoula Fire Weather Office Spot Fire Forecast for Canyon Creek Fire; Lake Creek and the Elk Creek Divisions, 0925 hrs. Thursday September 8, 1988)

Regional Weather: High pressure was moving into Montana from the west bringing generally clear skies and sunny weather across the state as the jetstream retreated to the north. Some high clouds still lingered in the northeast during the morning hours, where thunderstorms had occurred during the night. Winds diminished during the night and by 0500 hrs were generally less than 10 MPH. Smoke was mainly confined to the southwestern portion of the Region in the morning. Visibility was reported to be less than 2 miles at West Yellowstone, Dillon , Monida, and Cutbank. These areas of smoke gave way to mostly sunny skies in the late morning and early afternoon as light winds became more southwesterly with 10 to 20 MPH speeds and gusts to 25 MPH. Morning temperatures were quite a bit cooler following the frontal passage. Readings were in the 30's in parts of the west and north, with mostly 40's throughout the rest of the Region. At 0500 hrs temperatures ranged from 34 degrees at Kalispell to 51 at Billings. Afternoon temperatures were mainly in the 70's. High temperature in Yellowstone National Park ranged from the mid-60's to the mid-70's with minimum humidity readings of 10 to 20%. Winds remained out of the west and increased to 10 to 25 MPH east of the continental divide, with Livingston reaching gusts of 36 MPH (Bushey, 1989).

Long Range Forecast: Three to five day forecast indicated that warm and dry conditions on the 10th would start to change to cooler with showers on the 11th. There would be a chance of snow at the higher elevations in northern Idaho and western Montana. High temperatures on the 11th were expected to reach the 50's in the west and 60's in the east. The six to ten day outlook expected below normal temperatures and near normal to above normal precipitation (Bushey, 1989).

SEPTEMBER 9 (Julian Date 253)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 62.0
Seeley Lake Ranger Station; 3-day running mean ERC: 34.3
Gleason's Resort; 3-day running mean ERC: 64.5 (max high)

The ERC 80th percentile level (ERC = 37) is dropped below for the first time since July 15th at the Seeley Lake Ranger Station. This ERC level at Seeley Lake would not again be achieved during the 1988 season.

The station at Gleason's Resort achieved its highest ERC reading for the 1988 season.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 14.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 14.0%
Gleason's Resort; 3-day running mean 10 Hr: 4.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 9.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 14.6%
Gleason's Resort; 3-day running mean 1000 Hr: 11.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 12-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 19-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 26-4%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 23-9%
Spotted Bear, 24 hr High-Low range, 1 Hr fuel: 13-5%
Spotted Bear, 24 hr High-Low range, 10 Hr fuel: 15-9%

BEHAVE Fuel Moisture:

(West Zone)	24 hr High-Low range, 1 Hr fuel: 11-4% at 5600 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 5-4%
	24 hr High-Low range, 1 Hr fuel: 13-5% at 7800 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 6-5%
(East Zone)	24 hr High-Low range, 1 Hr fuel: 15-5% at 5200 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 6-5%
	24 hr High-Low range, 1 Hr fuel: 17-5% at 7200 ft msl
	1400 - 1900 hr High-Low range, 1 Hr fuel: 7-5%

RAWS Fire Weather: Monture 24 hr temperature range: 43-80F
Monture 24 hr relative humidity range: 16-54%
Monture 24 hr average 20 ft wind speed range (MPH): 1-17
Monture 24 hr range of maximum wind gusts (MPH): 3-30
(Monture 1400 hrs readings; 75F, 19%, 4 MPH)
Benchmark 24 hr temperature range: 33-73F
Benchmark 24 hr relative humidity range: 20-88%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-11

Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):5-40
(Benchmark 1346 hr readings; 73F, 20%, 9 MPH gusts to 40)

West Zone Fire Behavior: Fire showed some activity in both Bear and McDermott Creeks, but bucket drops kept it suppressed. A dozer line was constructed against the black in the McDermott Flats and direct attack with explosives was initiated in Bear Creek (Carlson, 1988). Afternoon west zone extreme afternoon burning conditions were; DB 65-75F, RH 15-25%, winds southwest / northwest 3-6 MPH (Carlson, 1988). Afternoon Probability of Ignition was 60%. The forecast called for 50 MPH winds from the north from a frontal passage. Lincoln Ranger District recorded .05" of rain and the predicted dry winds failed to develop.

1000 hrs. DB 56, WB 44, RH 41, wind calm. "Inversion still holding." (Ridge between Bear Creek and Coopers Lake, 5600 ft elevation, Fire Weather Observer, Lake Mountain Division.)

1008 hrs. Helicopters on the Lake Mountain Division were down due to (a lack of) visibility (due to smoke). (Helicopter Check-in and Mission Records)

1100 hrs. DB 59, WB 45, RH 36, wind south 0-1 MPH. "Inversion lifting, smoke is moving in from the flats." (Ridge between Bear Creek and Coopers Lake, 5600 ft elevation, Fire Weather Observer, Lake Mountain Division.)

1200 hrs. DB 63, WB 46, RH 29, wind south 0-2 MPH. "Smoke still coming from the flats." (Ridge between Bear Creek and Coopers Lake, 5600 ft elevation, Fire Weather Observer, Lake Mountain Division.)

1300 hrs. DB 68, WB 48, RH 24, wind south 3-4 MPH gusts to 6. "Fire is more active." (Ridge between Bear Creek and Coopers Lake, 5600 ft elevation, Fire Weather Observer, Lake Mountain Division.)

1400 hrs. DB 70, WB 49, RH 23, wind south 5-8 MPH gusts to 15. "Smoke across canyon indicates a southeast wind." (Ridge between Bear Creek and Coopers Lake, 5600 ft elevation, Fire Weather Observer, Lake Mountain Division.)

1500 hrs. DB 73, WB 50, RH 20, wind south 6-8 MPH gusts to 20. "Some gusts from the northwest, smoke generally going upslope." (Ridge between Bear Creek and Coopers Lake, 5600 ft elevation, Fire Weather Observer, Lake Mountain Division.)

1530 hrs. "He's on a ridge between Bear Creek and Cooper's Lake; squirrelly winds gusts 35 MPH out of northwest and brief south winds 20-25 MPH." (General Message from ground observers to Canyon Creek Fire, Lake Mountain Division Base - Operations.)

1600 hrs. DB 72, WB 50, RH 22, wind south 8-12 MPH gusts to 30. (Ridge between Bear Creek and Coopers Lake, 5600 ft elevation, Fire Weather Observer, Lake Mountain Division.)

1700 hrs. DB 74, WB 50, RH 19 (Ridge between Bear Creek and Coopers Lake, 5600 ft elevation, Fire Weather Observer, Lake Mountain Division.)

East Zone Fire Behavior: About 1300 hrs the wind began to pick up, about 1430 hrs strong sustained winds started a crowning fire run in Falls Creek, which jumped fireline and moved through Josylin Basin, and around Cuniff Basin. Probability of Ignition during this time period was at it's peak of 60% at the lower elevations and 50% at the higher elevations where the fire had burned. By the end of the fire run another 3,358 acres were burned bringing the total within fire perimeter acreage to 188,071 acres. This would be the final digitized fire acreage size.

Morning winds were light and variable (Jerry Dombroski Division A Supervisor E Zone, narrative).

1230-1300 hrs. Weather RH was 24% (Jerry Dombroski Division A Supervisor E Zone, narrative).

We knew there was fire in Falls Creek but because it was "smoked" in we could not recon it from the air...went off shift about 1345 or 1400...at that time there was little fire activity in either Falls Creek or Dearborn. It was smokey but not as smokey at this location as previous days (Jerry Hinman, off-duty Operations Chief E Zone, narrative).

1330 hrs. Winds were reported (Division G) to be picking up from the south increasing fire activity on the west side of Diamond-X (Falls Creek drainage) (Frank Boden, on-duty Ops. Chief E Zone, narrative).

1345 hrs. "Experiencing strong winds at Falls Creek wind southeast at 5." (Canyon Creek, Elk Division, radio log.)

1400-1430 hrs. I caught the first gust of wind from the south. There were spots up the creek, on each side, that had not moved for the last day and a half....About 10-15 minutes after the first gust of south wind, we started to get more. I could feel the humidity dropping...about 1430 the spots started to heat up some (Jerry Dombroski Division A Supervisor E Zone, narrative).

Somewhere about 1430 the wind picked up as well as the fire activity...soon after that the fire picked up and started to run (Dean Blomquist, Strike Team Leader Division G E Zone, narrative).

1500 hrs. Strong sustained winds were reported and substaintial fire activity on both sides of the drainage moving towards Josylin Basin and Diamond-X Ranch. The winds in Elk Creek Camp at this time were 25-30 MPH. Up until 1400 hrs all divisions except G reported little wind activity (Frank Boden, on-duty Ops. Chief E Zone, narrative).

1515 hrs. The Stanislaus Hot Shot Crew deployed shelters at Falls Creek.

1530 hrs. It was apparent that we would lose some or all of Falls Creek (Jerry Dombroski Division A Supervisor E Zone, narrative).

1556 hrs. "Skunk Creek Ranch has fire over hill" (Canyon Creek, Elk Division, radio log.)

1633 hrs. "Hot spot...near Bean Lake" (Canyon Creek, Elk Division, radio log.)

1630-1645 hrs. The hot shot foreman called, told me they had deployed shelters and had several minor burns (Jerry Dombroski Division A Supervisor E Zone, narrative).

1700 hrs. Heavy smoke at Choteau and Great Falls (USDA Northern Region, 1989).

1730 hrs. At Bean Lake the wind was gusting to 15-20 MPH, DB 72F and RH 15% (Dean Blomquist, Strike Team Leader Division G E Zone, narrative).

The fire came down Falls Creek Canyon as well as advancing to the east through Josylin Basin and broke over the ridge approximately 1730...in some 2 hours it had traveled 2 1/2 miles. when it broke over the ridge the flame lengths were in excess of 200' (Dean Blomquist, Strike Team Leader Division G E Zone, narrative).

2-300 ft flame length crown fire in Josylin Basin, not very rapid rate-of-spread. Peaked over ridge then backed down (Peila interview).

2240 hrs. "High wind warnings-have safe areas established and be prepared to use them." (Canyon Creek, Elk Division, radio log.)

Weather Forecast: 9am - Missoula. Red Flag Watch tonight and Saturday...Frontal Passage and Wind. Frontal system is forcast to develop in leading edge of upper level trough of low pressure and cross the region tonight and Saturday. Southwest to west wind will increase higher elevations tonight with southwest to northwest winds Saturday. Airmass still very dry into Saturday. Much cooler air from the north will move southward and over region Saturday afternoon into Sunday. Not much moisture indicated with this development at this time.

Today: Some high cloudiness and areas of smoke.
LAL: 1 CWR: 0
Max Temp: From 60s hi elevations to 70s & low 80s lower elevations.
Min Hum: 15 to 25%
Surface Winds: afternon and evening ridge winds southeast to southwest winds 15 higher exposed areas.
Free Air Winds: southwest to west 20

Tonight: Variable high and middle cloudiness.. chance few light showers N zones
LAL: 1 CWR: 0
Min Temp: 40s and low 50s...30s higher elevations
Max Hum: 55 to 70%..... 30 to 40% upper slopes and ridges
Surface Winds: southwest to northwest 10 to 15 gusty exposed areas 15 to 30 Hi ridges and exposed slopes.
Free Air winds: southwest to west 20 to 35

Tomorrow: Varaible cloudiness...chance of few light showers
LAL: 1 CWR: 0
Max Temp:cooling from the north Hi 60s north to 70s southern zones
Min Hum: likely rising in northern zones from 25 to 35%
Surface Winds: southwest to northwest 10 to 20 with 20 to 40 and gusty more exposed areas
Free Air winds: southwest to west 25 to 35

3-5 day outlook...much cooler with a chance of scattered showers Sunday and gusty northwest winds north exposed areas. Dry and breezy on Monday and Tuesday with slow warming. Highs 40s hi elevations and 55 to 65 valleys Sunday warming to 65 to 75 by Tuesday. Lows 30s and low 40s with teens and 20s in some mountain areas.

Regional Weather: Except for some smokey areas, skies were generally clear around Montana during the night. Great Falls reported an overcast of smoke around 10,000 feet during the morning and visibility was reduced by smoke to 1/8 mile at West Yellowstone and about 1/2 mile at Livingston. Early morning (0600 hrs) temperatures ranged from 33 at Butte to 53 at Billings. A cold front moved into western Montana during the afternoon from the northwest, bringing winds of 15 to 30 MPH. Afternoon temperatures warmed into the 70's and 80's. At 1800 hrs extremes ranged from 73 at Glasgow to 87 degrees at Dillon, Bozeman, and Belgrade. Winds were increasing by the afternoon and were 10 to 20 MPH west of the divide out of the southwest with some gusts to 30 MPH reported, and east of the divide winds were southeast at the same speeds. Red Flag Watches were issued for the night in northern Idaho and western Montana for winds associated with another frontal passage. Similar warnings were also issued for the Greater Yellowstone area. The watches were upgrade to warnings for western Montana and northern Idaho at 1845 hrs as the frontal system began to move faster than expected (Bushey, 1989).

SEPTEMBER 10 (Julian Date 254)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 44.6
Seeley Lake Ranger Station; 3-day running mean ERC: 29.0
Gleason's Resort; 3-day running mean ERC: 44.0

The Lincoln Ranger Station ERC level drops below the 80th percentile level (ERC = 49) for the first time since July 19th. This high level would not again be achieved during the 1988 season.

The Gleason's Resort Station dropped below the ERC 97th percentile level (ERC = 48).

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 21.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 20.0%
Gleason's Resort; 3-day running mean 10 Hr: 11.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.3%
Gleason's Resort; 3-day running mean 1000 Hr: 13.5%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 54-8%
Monture, 24 hr High-Low range, 10 Hr fuel: 33-9%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 30-11%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 41-16%
Spotted Bear, 24 hr High-Low range, 1 Hr fuel: 27-9%
Spotted Bear, 24 hr High-Low range, 10 Hr fuel: 27-11%

BEHAVE Fuel Moisture:

(West Zone) 24 hr High-Low range, 1 Hr fuel: 31-7% at 5600 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 28-27%
24 hr High-Low range, 1 Hr fuel: 34-8% at 7800 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 33%

(East Zone) 24 hr High-Low range, 1 Hr fuel: 38-9% at 5200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 38%
24 hr High-Low range, 1 Hr fuel: 47-9% at 7200 ft msl
1400 - 1900 hr High-Low range, 1 Hr fuel: 47%

RAWS Fire Weather: Monture 24 hr temperature range: 38-54F
Monture 24 hr relative humidity range: 39-91%
Monture 24 hr average 20 ft wind speed range (MPH): 0-10
Monture 24 hr range of maximum wind gusts (MPH): 1-16
(Monture 1400 hrs readings; 54F, 39%, 5 MPH)
(Monture received .16" of rain/snow between 1600-2400 hrs, first moisture since August 7th, 34 days.)
Benchmark 24 hr temperature range: 32-47F
Benchmark 24 hr relative humidity range: 54-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-10
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):2-21
(Benchmark 1346 hr readings; 37F, 96%, 3 MPH gusts to 16)
(Benchmark received .29" of moisture between 1200-2400 hrs.)

Weather: By 1500 hrs they were in a major rain. Between 1600-1700 hrs in started to snow, pulled crews in Dearborn drainage. That night the area had +/- 6" of snow. (Peila interview)

0751 hrs. "Visibility 3/4 mile. Area valleys smoked in." (Canyon Creek Fire, Lake Mountain Division Helibase log.)

1056 hrs. "I would like to place an order for Christmas decorations and a snow shovel...I'm getting enough snow its beginning to cover the ground." (Beartop Lookout above Gates Park Fire to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1057 hrs. "We are getting steady drizzle and have been for about twenty minutes." (Gates Park Fire Base Camp to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

1315 hrs. Rain fell on the fire. It was heavy at times at various locations. Rain fell on most of the fire during the night with some locations turning to snow (10-18" falling at some locations on the east zone). Lincoln Ranger District recorded .58" Crews on the east zone were moved to Great Falls to escape the weather (USDA Northern Region, 1989).

Snow! (Carlson, 1988).

Regional Weather: The Red Flag Warnings issued the previous night remained in effect. A deep low pressure system had developed over Montana but no significant moisture appear during the night. Cold front was on a line from Malta-Great Falls at 0800 hrs and an area of upslope rain had developed in central Alberta. Cold Canadian air spilled down across the Region behind the

front. The slowness of the system to evolve had allowed the moisture potential of the system to improve some. At 1103 hrs Missoula radar spotted some light, scattered showers in northwest Montana. These were in Lincoln, northwest Lake, southern Flathead, northern Missoula, and Powell counties. Some weak showers were detected southwest of Helena. Light rain was reported to be falling at Spokane and Walla Walla, Washington. At 1300 hrs a report of heavy snow down to the 5,500 foot elevation in the Polebridge area was helping fire crews on the Red Bench Fire. By late afternoon scattered light rain showers were being reported over much of western Montana. These showers developed into locally heavy precipitation across western and central Montana. Light rain started falling in the Yellowstone area late in the day. Gusty northerly winds also developed with Glasgow reporting wind speeds over 40 MPH and several other stations with speeds between 30 to 35 MPH. At 1800 hrs temperatures ranged from 67 degrees at Miles City to 43 at both Butte and Lewistown.

SEPTEMBER 11 (Julian Date 255)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 30.6
Seeley Lake Ranger Station; 3-day running mean ERC: 23.6
Gleason's Resort; 3-day running mean ERC: 25.5

ERC levels at the Gleason's Resort dropped down below the 80th percentile levels (ERC = 35) for the first time since July 12th.

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 27.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 26.3%
Gleason's Resort; 3-day running mean 10 Hr: 16.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 13.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 15.6%
Gleason's Resort; 3-day running mean 1000 Hr: 16.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 54-9%
Monture, 24 hr High-Low range, 10 Hr fuel: 32-14%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 31-28%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 43-38%

RAWS Fire Weather: Monture 24 hr temperature range: 36-50F
Monture 24 hr relative humidity range: 48-91%
Monture 24 hr average 20 ft wind speed range (MPH): 1-7
Monture 24 hr range of maximum wind gusts (MPH): 5-17
(Monture 1400 hrs readings; 43F, 69%, 3 MPH)
(Monture continued to receive moisture, an additional .05" between 0000-1200 hrs.)
Benchmark 24 hr temperature range: 30-39F
Benchmark 24 hr relative humidity range: 93-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-4
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):0-11
(Benchmark 1346 hr readings; 38F, 100%, 0 MPH gusts to 2)
(Benchmark received another .26" of moisture between 1200-2000 hrs.)
(figures 97 - 100)

Figure 97. Monture RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and precipitation measurements for September 11 - September 15, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

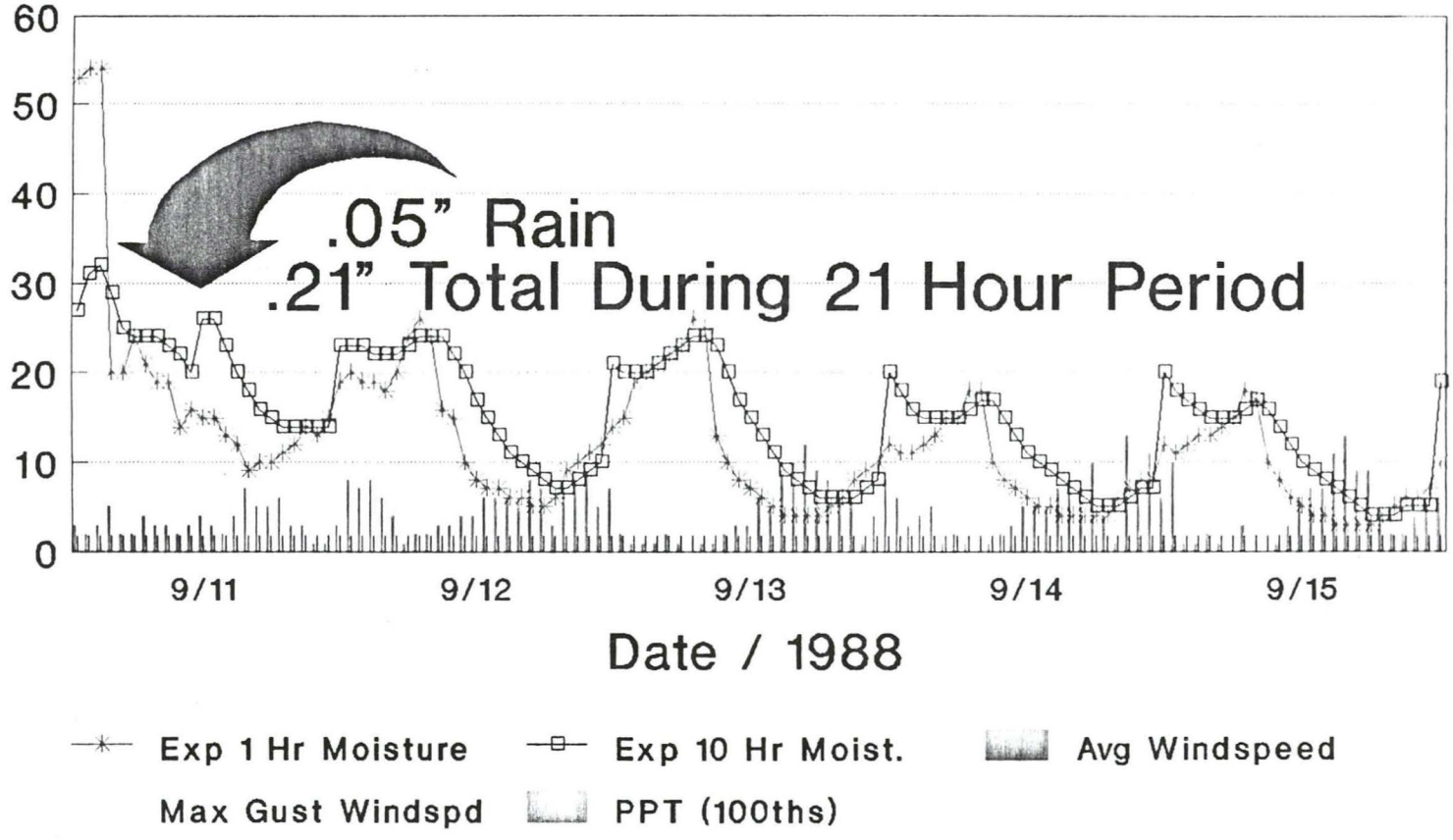


Figure 98. Monture RAWS Station air temperature, relative humidity, average wind speed, maximum gust wind speed, and precipitation measurements for September 11 - September 15, 1988 (MST).

Fire Weather

Monture Station RAWS (333333)

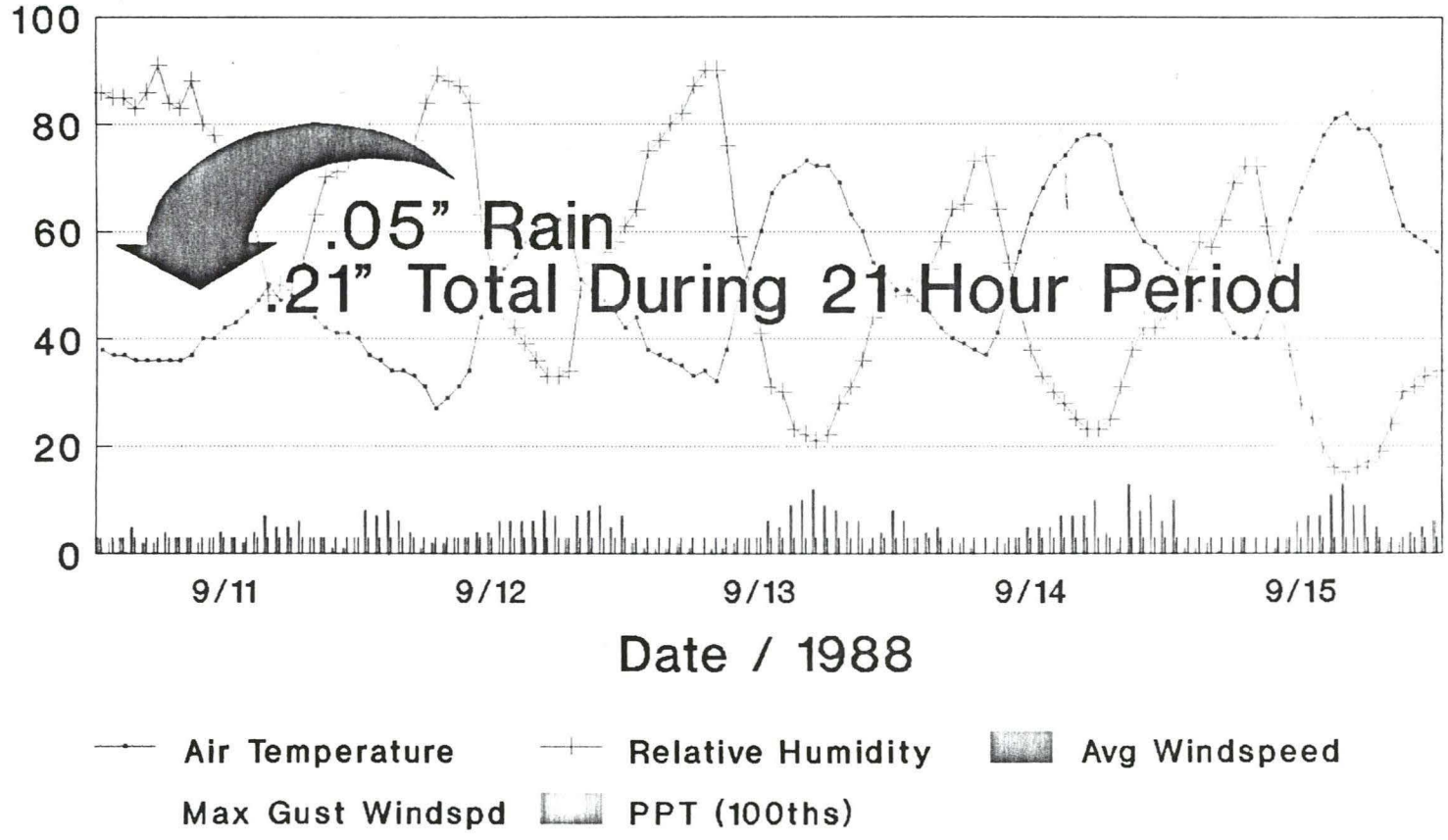


Figure 99. Benchmark RAWS Station Experimental 1 Hour and Experimental 10 Hour fuel moisture, average wind speed, maximum gust wind speed, and preciptation measurements for September 11 - September 15, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)

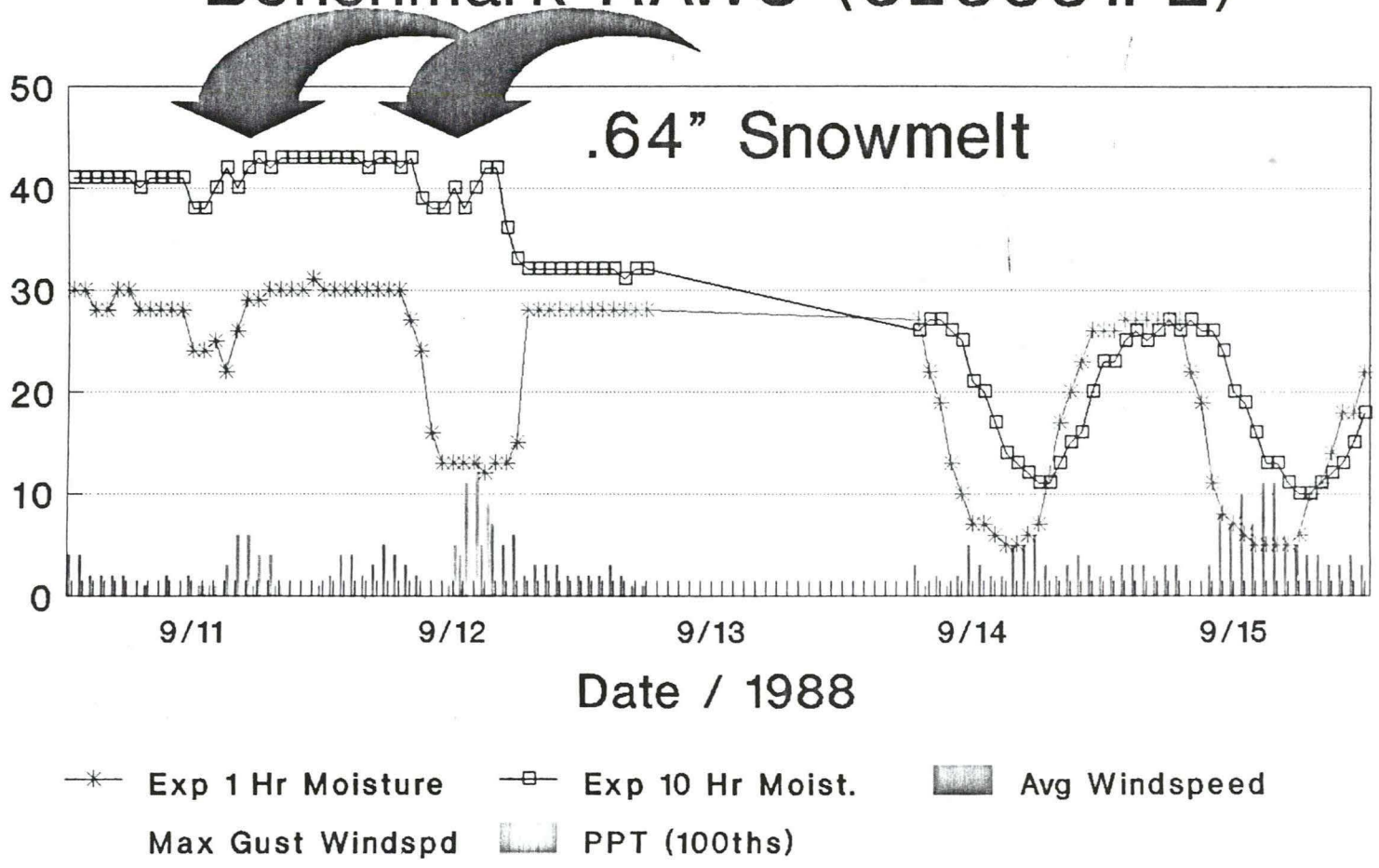
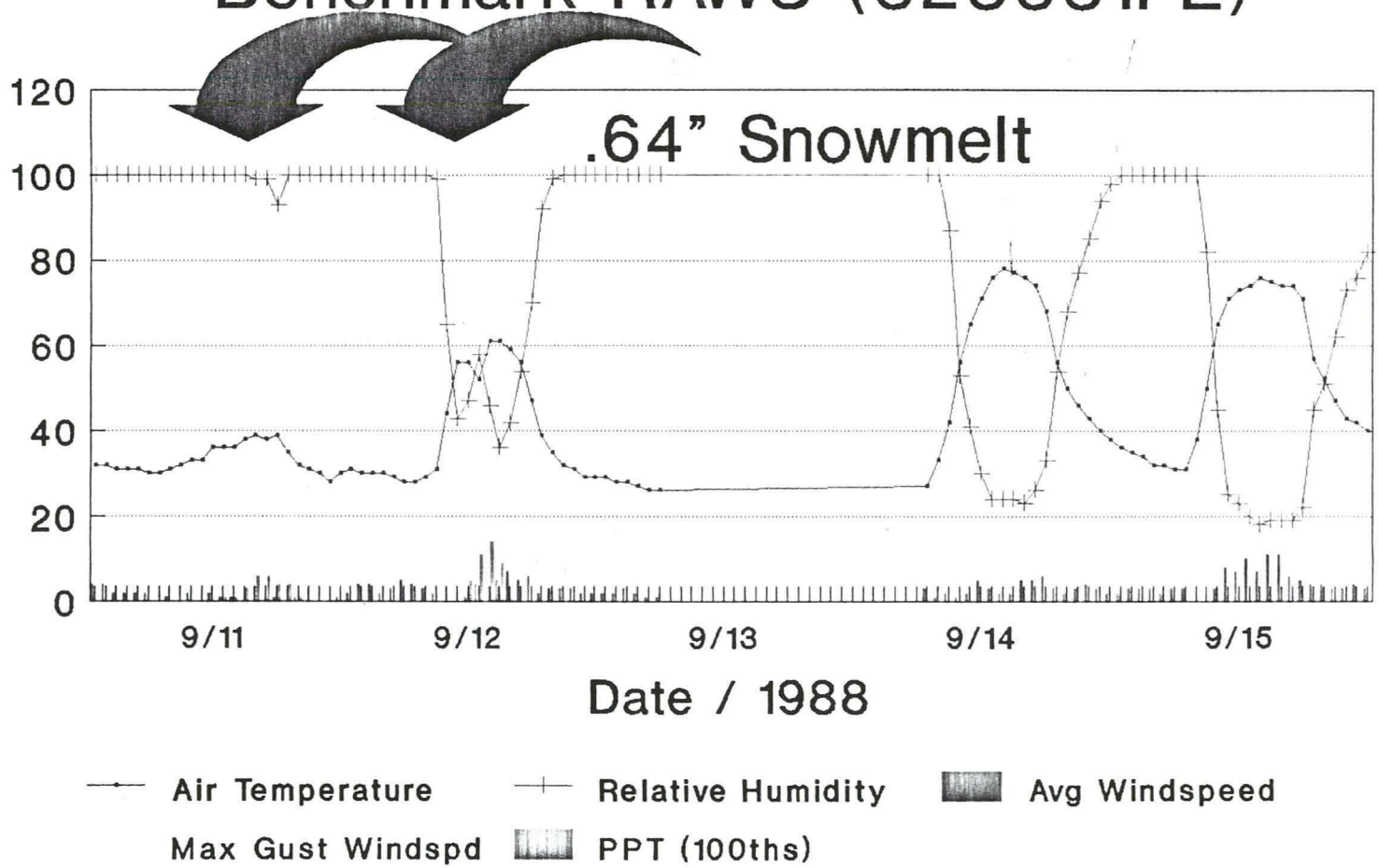


Figure 100. Benchmark RAWS Station air temperature, relative humidity, average wind speed, maximum gust wind speed, and precipitation measurements for September 11 - September 15, 1988 (MST).

Fire Weather

Benchmark RAWS (323331FE)



Regional Weather: It was cloudy and cold with northerly winds and scattered precipitation across Montana during the night. Great Falls had cold rain and wet snow most of the night, Butte reported 2" of snow, as did Lookouts on the Kooteani National Forest. Rain with snow fell above 5,000' in upslope areas with some precipitation sloping over the mountains into Yellowstone National Park. However, no moisture was being received in West Yellowstone and Gardiner and by late morning only a little had fallen in Cooke City. By the end of the day most of Yellowstone had .5 to 2" of snow, and up to 4" on the higher peaks around Cooke City, the Beartooth pass, and Red Lodge. Most areas in northern Idaho only received light precipitation of a few hundreds of an inch. Low temperatures this morning were in the 30's and 40's in all but a few locations. Temperatures ranged from 32 at Great Falls to 47 at Miles City. During the afternoon rain, snow, and fog continued to be reported east of the divide. In northern Idaho and western Montana high pressure was again beginning to rebuild. By the end of the day measurable precipitation had been received over most of the state except in the northeast and extreme southwest corners. Snow depths of 1 to 4" were measured at higher elevations. The first measurable precipitation was reported by Harve since the 5th of July. Afternoon temperatures did not warm up much. By 1800 hrs temperature extremes ranged from 37 degrees at West Yellowstone to 66 at Thompson Falls. Most afternoon temperatures in Yellowstone National Park were in the 30's and 40's. Northern Idaho warmed into the 60's, and further west in the coastal areas of Oregon and Washington temperatures were in the 80's. Frost and freezing temperatures were possible during the upcoming night (Bushey, 1989).

0815 hrs. "8-12 inches (snow) where the wind isn't blowing." (Patrol Mountain Lookout to the Rocky Mountain District, Lewis and Clark National Forest, radio log.)

SEPTEMBER 12 (Julian Date 256)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 23.0
Seeley Lake Ranger Station; 3-day running mean ERC: 27.6
Gleason's Resort; 3-day running mean ERC: 27.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 28.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 20.3%
Gleason's Resort; 3-day running mean 10 Hr: 14.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%
Gleason's Resort; 3-day running mean 1000 Hr: 16.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 20-5%
Monture, 24 hr High-Low range, 10 Hr fuel: 24-7%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 30-13%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 43-32%

RAWS Fire Weather: Monture 24 hr temperature range: 27-63F
Monture 24 hr relative humidity range: 33-89%
Monture 24 hr average 20 ft wind speed range (MPH): 1-9
Monture 24 hr range of maximum wind gusts (MPH): 7-17
(Monture 1400 hrs readings; 53F, 45%, 6 MPH)
Benchmark 24 hr temperature range: 28-61F
Benchmark 24 hr relative humidity range: 36-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-7
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):2-11
(Benchmark 1346 hr readings; 61F, 36%, 5 MPH gusts to 10)
(Benchmark continued to received moisture, .40" between 0900-1500 hrs.)

0912 hrs. "Canyon Creek looks dead except for west end upper reaches of Blackfoot." (Lolo National Forest Fire Dispatch radio log.)

A bright sun and temperatures in the 60's allowed the crews to attack the fire front with some mop-up (USDA Northern Region, 1989).

Regional Weather: Skies cleared over the northern portion of the Region during the night, elsewhere there were cloudy to partly cloudy skies. Snow flurries continued at Butte and light rain at Billings during the night. Several stations reported patchy fog. Wind conditions were light to less than 15 MPH. Precipitation had pretty much ended by about 0600 hrs. The Northern Rocky Mountains from the Seely Lake-Lincoln areas south through Anaconda and Butte received a very good wetting rain the previous 24 hours. Also parts of central and eastern Montana had good rains. Several stations in central Montana reported total rainfall amounts in excess of 2", and a number with amounts of an inch or more. The largest amount was 2.38" at Shonkin. The western edge of Montana and northern Idaho only received very light, scattered showers. In Yellowstone National Park .5" to 2" of snow fell across the higher elevations. Water equivalent of this snow was generally .25" or less. Temperatures overnight were in the 30's and 40's at most stations with frost being common in many areas. At 0600 hrs temperatures ranged from 23 at West Yellowstone to 46 at Miles City. In Missoula 29 degrees tied the record cold for this date in September (1964) (Bushey, 1989).

Long Range Forecast: The three to five day outlook was for dry, cool nights and warm afternoons. A chance of a few showers, wind and some minor cooling by the 16th. In six to ten days the outlook was for above normal temperatures and mostly dry west of the divide, and normal temperatures and precipitation east of the divide (Bushey, 1989).

SEPTEMBER 13 (Julian Date 257)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 29.6
Seeley Lake Ranger Station; 3-day running mean ERC: 30.0
Gleason's Resort; 3-day running mean ERC: 29.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 21.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 15.3%
Gleason's Resort; 3-day running mean 10 Hr: 11.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%
Gleason's Resort; 3-day running mean 1000 Hr: 16.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 26-4%
Monture, 24 hr High-Low range, 10 Hr fuel: 24-6%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 28-7%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 32-15%

RAWS Fire Weather: Monture 24 hr temperature range: 32-73F
Monture 24 hr relative humidity range: 21-90%
Monture 24 hr average 20 ft wind speed range (MPH): 0-12
Monture 24 hr range of maximum wind gusts (MPH): 3-23
(Monture 1400 hrs readings; 67F, 31%, 6 MPH)
Benchmark 24 hr temperature range: 28-66F
Benchmark 24 hr relative humidity range: 36-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-9
(Benchmark 1346 hr readings; 65F, 37%, 9 MPH)
(Benchmark measured another .01" of moisture when temperatures went above the freezing mark.)

Regional Weather: The low pressure system that had brought the moisture to the Region was now off over west-central Utah. Clouds from the low were still over southern Montana this morning with some showers being reported in Monida, West Yellowstone, and Billings. The remaider of Montana and Idaho was under the influence of a large ridge of high pressure that extended north into Alberta. No precipitation was reported across Montana during the last 24 hours ending at 0600 hrs. Low temperatures during the morning were quite variable, with most locations in the mid to upper 30's, and some 40's along the Canadian border in eastern Montana. At 0600 hrs temperatures ranged from 30 degrees at Butte to 43 at Billings. During the afternoon most of Montana had sunny skies except for the south which was partly cloudy to cloudy with light rain showers in the southcentral and southwest mountainous portions of the Region. Winds were generally less than 15 MPH, with Livingston being the exception with winds 20 to 25 MPH out of the southeast. Smoke lowered visibility to 10 miles or less in the Kalispell vicinity. Afternoon temperatures remained mild ranging from 53 degrees at Billings to 88 at Thompson Falls (Bushey, 1989).

SEPTEMBER 14 (Julian Date 258)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 34.3
Seeley Lake Ranger Station; 3-day running mean ERC: 33.3
Gleason's Resort; 3-day running mean ERC: 32.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 9.6%
Gleason's Resort; 3-day running mean 10 Hr: 9.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%
Gleason's Resort; 3-day running mean 1000 Hr: 16.6%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 18-4%
Monture, 24 hr High-Low range, 10 Hr fuel: 20-5%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-5%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 27-11%

RAWS Fire Weather: Monture 24 hr temperature range: 37-78F
Monture 24 hr relative humidity range: 23-74%
Monture 24 hr average 20 ft wind speed range (MPH): 0-13
Monture 24 hr range of maximum wind gusts (MPH): 2-18
(Monture 1400 hrs readings; 68F, 33%, 5 MPH)
Benchmark 24 hr temperature range: 27-78F
Benchmark 24 hr relative humidity range: 23-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 1-6
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):2-14
(Benchmark 1346 hr readings; 77F, 24%, 2 MPH gusts to 8)

Fire not active due to snow that fell over the previous few days (Bonney, 1988).

Gauger's Class II team released. (USDA Northern Region, 1989)

1130 hrs. DB 66, WB 52, RH 42, wind southeast 3-4 MPH. (Ridge south of East Spread Mountain, 6100 ft elevation, Fire Weather Observer, Lake Mountain Division.)

1300 hrs. DB 74, WB 57, RH 41, wind south-southeast 0-2 MPH. (Almost to McCabe Creek, Fire Weather Observer, Lake Mountain Division.)

1500 hrs. DB 68, WB 40, RH 40, wind southeast 0-3 MPH. "That's all folks." (Junction McCabe Creek trail and Lake Otatsy trail, 5400 ft elevation, Fire Weather Observer, Lake Mountain Division.)

Regional Weather: Variable cloudiness and scattered showers occurred along the southern border of the Region during the night. Skies were fair and winds light over the rest of the area. Low temperatures in Montana this morning were mostly in the 40's and low 50's, ranging from 32 degrees at Drummond to 52 at Miles City. During the afternoon the southern border remained cloudy and cool while the rest of the Region had sunny skies and light winds. Afternoon temperatures were in the upper 60's and 70's, with highs ranging from 61 at West Yellowstone to 95 at Thompson Falls. The Northwest also had sunny skies with temperatures ranging from 60's along the west coast and southern Idaho, and into the 80's across northern Idaho (Bushey, 1989).

SEPTEMBER 15 (Julian Date 259)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 36.6
Seeley Lake Ranger Station; 3-day running mean ERC: 34.3
Gleason's Resort; 3-day running mean ERC: 32.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 8.6%
Gleason's Resort; 3-day running mean 10 Hr: 8.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.3%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.0%
Gleason's Resort; 3-day running mean 1000 Hr: 17.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 18-3%
Monture, 24 hr High-Low range, 10 Hr fuel: 20-4%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-5%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 27-10%

RAWS Fire Weather: Monture 24 hr temperature range: 40-82F
Monture 24 hr relative humidity range: 15-72%
Monture 24 hr average 20 ft wind speed range (MPH): 0-13
Monture 24 hr range of maximum wind gusts (MPH): 2-28
(Monture 1400 hrs readings; 73F, 25%, 7 MPH)
Benchmark 24 hr temperature range: 31-76F
Benchmark 24 hr relative humidity range: 18-100%
Benchmark 24 hr average 20 ft wind speed range (MPH): 0-11
Benchmark 24 hr range of maximum 20 ft wind gusts(MPH):2-27
(Benchmark 1346 hr readings; 75F, 19%, 11 MPH gusts to 27)

Regional Weather: Morning skies were mostly clear across the Region except the southern half of Montana and along the Montana-Dakotas border. Winds were generally 15 MPH or less, with stations in western Montana reporting mostly 10 MPH or less. Overnight low temperatures ranged from the 30's in the southwest to the mid-50's in the east. At 0600 hrs Butte was the coolest spot with 34, the warmest was 56 at Great Falls. By the afternoon sunny skies and warm temperatures were across the Region. Afternoon temperatures rose to the 70's and lower 80's, ranging from 66 at West Yellowstone to 90 at Thompson Falls. Strongest winds were in the Livingston area with gusts over 30 MPH, other areas reported 10 to 20 MPH gusts (Bushey, 1989).

SEPTEMBER 16 (Julian Date 260)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 37.5
Seeley Lake Ranger Station; 3-day running mean ERC: 28.6
Gleason's Resort; 3-day running mean ERC: 27.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 16.0%
Gleason's Resort; 3-day running mean 10 Hr: 13.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 15.5%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.3%
Gleason's Resort; 3-day running mean 1000 Hr: 17.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 11-4%
Monture, 24 hr High-Low range, 10 Hr fuel: 17-5%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 27-6%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 26-11%

1015 hrs. "Poor visibility, 10 miles." (Silver King radio log.)

1355 hrs. "Visibility 8 miles, drizzle." (Silver King radio log.)

1600 hrs. "Visibility down to 5 miles." (Silver King radio log.)

1700 hrs. "Sun shining, visibility still poor, smokey, 5 miles." (Silver King radio log.)

1800 hrs. "Visibility improving. Valley still socked in southwest. Large building cumulus north / northwest. Haven't seen any developing enough for lightning." (Silver King radio log.)

2030 hrs. "Socked in, winds calm." (Silver King radio log.)

Regional Weather: Skies were mostly clear during the night, however by daybreak clouds associated with a dry Pacific weather front were moving over western Montana. Winds across the Region were generally less than 15 MPH, except for Billings which reported morning gusts of 20 MPH at times. Overnight low temperatures ranged from the mid-30's in the southwest to the mid-50's in the southcentral, West Yellowstone was the coolest at 33 and Billings the warmest at 56. By late afternoon the western half of the Region was under mostly cloudy skies, scattered showers and thunderstorms. Lightning started at 1312 hrs north of Helena and progressed to the northeast across Great Falls, Harve, and Harlem. Separate thunderstorm cells developed in the Choteau / Conrad areas along the eastern Rocky Mountain front, and over the Charles Russell National Wildlife Refuge and the Musselshell River in eastern Montana. Between 1312 hrs and 0503 hrs on the 17th there were 865 lightning strikes. The east half of the Region remained partly cloudy. Afternoon temperatures were 75 to 85 in the eastern half of Montana, 60's and low 70's elsewhere. Several areas reported 10 to 25 MPH winds. Only Great Falls had measurable precipitation by 1800 hrs, more rain fell during the night at Great Falls and also at Glasgow. Other locations had traces (Bushey, 1989).

SEPTEMBER 17 (Julian Date 261)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 22.0
Seeley Lake Ranger Station; 3-day running mean ERC: 22.3
Gleason's Resort; 3-day running mean ERC: 22.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 20.5%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 24.6%
Gleason's Resort; 3-day running mean 10 Hr: 21.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 18.5%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 16.6%
Gleason's Resort; 3-day running mean 1000 Hr: 17.0%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 54-9%
Monture, 24 hr High-Low range, 10 Hr fuel: 33-12%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 29-18%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 34-21%

East zone crews worked hot spots in Moudess. Fire was declared contained. West zone crews completed fireline from Echo Pass to East Spread Mountain. West zone fire camp received 3" of snow and intermittent rain. Lincoln Ranger District received .89" of precipitation (USDA Northern Region, 1989).

During the last 2 days Lincoln Ranger District received 1.76" of moisture.

1000 hrs. "Socked in." (Silver King radio log.)

1000 hrs. Rain gauge west of Parker Lake recorded 3.09" (USDA Northern Region, 1989).

1630 hrs. Lincoln Ranger Station reports the "snow isn't sticking." Silver King Lookout is still "socked in." (Silver King radio log.)

Regional Weather: Skies were mostly cloudy across the region last night as a cold front moved through accompanied by scattered showers, thundershowers and gusty winds. Winds were generally 15 MPH or less across Montana during the night. As the front passed Billings reported gusts up to 45 MPH were reported. At 0600 hrs low morning temperatures ranged from the mid-30's in the southwest portion of the Region to the mid-50's in the southeast. Butte was the coldest spot at 34 degrees, Broadus was the opposite extreme at 54 (Bushey, 1989).

SEPTEMBER 18 (Julian Date 262)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 9.5
Seeley Lake Ranger Station; 3-day running mean ERC: 15.3
Gleason's Resort; 3-day running mean ERC: 16.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 30.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 33.3%
Gleason's Resort; 3-day running mean 10 Hr: 29.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 20.5%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 17.0%
Gleason's Resort; 3-day running mean 1000 Hr: 17.3%

RAWS Fuel Moisture: Monture, 24 hr High-Low range, 1 Hr fuel: 54-14%
Monture, 24 hr High-Low range, 10 Hr fuel: 31-19%
Benchmark, 24 hr High-Low range, 1 Hr fuel: 30-13%
Benchmark, 24 hr High-Low range, 10 Hr fuel: 40-33%

Regional Weather: A strong rain storm contained to move across the Region for the second day, bringing snow, rain, and unseasonably cool temperatures. Virtually all of Montana had received significant amounts of precipitation. The heaviest precipitation today shifted into the eastern half of the Region. There were scattered heavy thunderstorms in southeast and extreme eastern Montana. By afternoon it was snowing heavily in Great Falls (7" by noon) and in Lewistown, and a mixture of snow and rain at several other locations. Several RAWS units in the central part of Montana recorded .33" to .75"'s of rain in a 6 hour period. West of Havre to Great Falls to Butte the line of rain and snow ended. In the northwestern portion of the Region the skies were clearing and partly sunny. Afternoon temperatures were in the lower 50's west of the divide and east along the hi-line to Havre, elsewhere only in the 35 to 45 degree range. Winds of 15 to 30 MPH were common in the eastern portion of the Region (Bushey, 1989).

SEPTEMBER 19 (Julian Date 263)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 11.6
Seeley Lake Ranger Station; 3-day running mean ERC: 16.3
Gleason's Resort; 3-day running mean ERC: 15.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 26.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 30.0%
Gleason's Resort; 3-day running mean 10 Hr: 29.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 20.3%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 17.0%
Gleason's Resort; 3-day running mean 1000 Hr: 17.6%

Recon revealed that there were still a lot of smokes, particularly in the Mineral and Meadow Creek drainages and in the Sourdough area above Packer Lake (USDA Northern Region, 1989).

Regional Weather: Low 0600 hrs temperatures ranged from the upper 20's to mid-30's across most of the Region; northern Idaho and southwestern Montana had lows in the upper 40's. West Yellowstone had the coolest temperature at 20 degrees, Dillon the warmest at 49. Most of western Montana and northern Idaho remained cloudy during the day as an upper level low moved into the western portion of the Region. Rain from this new system had been falling in some

northwestern areas nearly all day. The eastside of the divide remained partly cloudy. Winds were generally light across Montana. Afternoon high temperatures were mostly in the 50's, with Broadus the warmest spot at 61. Most of the snow which had fallen along the east slopes of the Rockies and in central Montana yesterday had melted by noon (Bushey, 1989).

SEPTEMBER 20 (Julian Date 264)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 16.3
Seeley Lake Ranger Station; 3-day running mean ERC: 19.0
Gleason's Resort; 3-day running mean ERC: 17.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 22.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 23.6%
Gleason's Resort; 3-day running mean 10 Hr: 22.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 20.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 17.3%
Gleason's Resort; 3-day running mean 1000 Hr: 18.3%

Regional Weather: Mostly cloudy skies across the Region during the night, with light rain at Butte, Kalispell, and Helena. Winds at most stations were light and less than 10 MPH. Glasgow was the exception with winds southeasterly 10 to 20 MPH. Most morning low temperatures were slightly warmer than the preceding days, up in the 40's. Coldest location was West Yellowstone at 35 degrees, warmest was Livingston at 46. As the day progressed a steady rain continued to fall in a band from central to southwest Montana. elsewhere it was partly cloudy. Afternoon temperatures ranged from the mid-40's through the 50's (Bushey, 1989).

SEPTEMBER 21 (Julian Date 265)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 20.6
Seeley Lake Ranger Station; 3-day running mean ERC: 23.0
Gleason's Resort; 3-day running mean ERC: 22.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 16.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 17.0%
Gleason's Resort; 3-day running mean 10 Hr: 16.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 20.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 17.6%
Gleason's Resort; 3-day running mean 1000 Hr: 18.6%

Regional Weather: Skies over the Region slowly cleared during the night, and no rainfall had been reported since midnight. Overnight low temperatures were in the 30's and 40's, and at 0600 hrs ranged from 33 at Missoula to 43 at Miles City. Moisture near the ground from the recent rains helped produce morning fog in some southwest and western valleys. During the day drier air moved into the Region from the west and brought sunny skies by the afternoon. Afternoon winds of 15 to 30 MPH from the west or southwest were common across the plains, and local gusts to 25 MPH in the western portion of the Region. These winds were

produced by a low pressure system moving through southern Canada. Afternoon high temperatures were mostly in the 60's but ranged from 59 at Libby to 72 at Glendive (Bushey, 1989).

SEPTEMBER 22 (Julian Date 266)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 24.0
Seeley Lake Ranger Station; 3-day running mean ERC: 26.0
Gleason's Resort; 3-day running mean ERC: 25.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 13.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 13.0%
Gleason's Resort; 3-day running mean 10 Hr: 11.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 20.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 18.0%
Gleason's Resort; 3-day running mean 1000 Hr: 19.0%

Regional Weather: Skies were clear to partly cloudy over the Region during the night. Winds were light to less than 15 MPH at most stations. Temperatures overnight were in the 30's and 40's, and ranged at 0600 hrs from 29 at Butte to 45 at Billings. Wisdom later reported the lowest temperature of 15 degrees. Skies remained mostly clear throughout the day, winds remained light with Great Falls reporting the strongest at 13 MPH at midday. High afternoon temperatures ranged from 58 at West Yellowstone to 73 at Thompson Falls (Bushey, 1989).

SEPTEMBER 23 (Julian Date 267)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 26.6
Seeley Lake Ranger Station; 3-day running mean ERC: 29.0
Gleason's Resort; 3-day running mean ERC: 25.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 10.6%
Gleason's Resort; 3-day running mean 10 Hr: 11.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 20.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 17.6%
Gleason's Resort; 3-day running mean 1000 Hr: 19.3%

Regional Weather: Skies were generally fair through the night. Winds remained light and variable, and less than 10 MPH. Morning temperatures were in the 30's and 40's, and at 0600 hrs ranged from 29 at Butte to 44 at Great Falls and Billings. Afternoon skies were mostly sunny in the southern half of the Region and cloudy over the northern half. Wind speeds had picked up along the east slope of the Rockies with speeds of over 30 MPH reported at some locations. Temperatures were mild and ranged from 60 degrees at West Yellowstone to 77 at Broadus, 76 at Thompson Falls, and 75 at Hamilton. Light rain was falling today along the Washington coast and along the northern border of east Washington and moving west (Bushey, 1989).

SEPTEMBER 24 (Julian Date 268)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 28.6
Seeley Lake Ranger Station; 3-day running mean ERC: 30.6
Gleason's Resort; 3-day running mean ERC: 24.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 8.6%
Gleason's Resort; 3-day running mean 10 Hr: 12.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 19.6%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 17.6%
Gleason's Resort; 3-day running mean 1000 Hr: 19.3%

Regional Weather: Morning skies were partly cloudy to cloudy. Winds were generally light and less than 15 MPH at most stations. Kalispell was the only regular reporting station reporting any precipitation during the previous 24 hours ending at 0600 hrs and received .03". A few sprinkles were reported around the Missoula area, and parts of Glacier National Park also received some moisture including snow at the higher elevations. Overnight temperatures were warmer than the previous morning and were between the 40's and 50's. At 0600 hrs Cutbank reported 34 degrees for the coolest spot and Billings was the warmest at 51. Skies remained cloudy through the day over the western portion of the Region and the clouds were gradually spreading eastward. Afternoon temperatures warmed into the 60's and low 70's with the highs ranging from 55 at Cutbank to 75 at Broadus, 76 at Hamilton, and 78 at Hardin (Bushey, 1989).

SEPTEMBER 25 (Julian Date 269)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 31.6
Seeley Lake Ranger Station; 3-day running mean ERC: 31.0
Gleason's Resort; 3-day running mean ERC: 23.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 8.6%
Gleason's Resort; 3-day running mean 10 Hr: 13.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 18.6%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 17.6%
Gleason's Resort; 3-day running mean 1000 Hr: 19.3%

1521 hrs. "Bucket work mouth of Mineral Creek." (Silver King Lookout radio log.)

Regional Weather: Cloudy skies continued over the western portion of the Region while east of the divide skies were mostly clear in the morning. Scattered showers fell throughout the northwest portion of the Region with Kalispell being the only regular reporting station recording moisture with .03" as of 0600 hrs. During the night temperatures fell into the 40's across most of the Region, and ranged from 31 at Butte to 47 at Miles City at 0600 hrs. During the afternoon a surface low pressure system was centered over western Montana with a stationary front extending from Alberta through eastern

Montana. Clouds covered most of the state by the end of daylight and gusty winds were common. In western Montana gusts over 30 MPH were frequent, and in Livingston a gust of 44 MPH was reported. Occasional light rain and rain showers continued falling west of the divide from Kalispell south to Missoula then southwest to Grangeville, Idaho. Afternoon temperatures were very mild ranging from 55 at Kalispell to 80 degrees at Big Timber (Bushey, 1989).

SEPTEMBER 26 (Julian Date 270)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 27.6
Seeley Lake Ranger Station; 3-day running mean ERC: 25.0
Gleason's Resort; 3-day running mean ERC: 21.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 18.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 16.6%
Gleason's Resort; 3-day running mean 10 Hr: 16.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 18.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 18.0%
Gleason's Resort; 3-day running mean 1000 Hr: 19.0%

Regional Weather: Cloud cover continued across the Region during the night and increased as the day progressed. Temperatures fell into the 40's and 50's during the night, and at 0500 hrs ranged from 37 degrees at Butte to 54 at Glasgow. Cloud cover also extended westward across northern Idaho and the majority of the state of Washington where morning temperatures were similar to Montana. Afternoon temperatures were in the 60's and 70's across the Region. Scattered showers continued west of the divide and adjacent plains to the east (Bushey, 1989).

SEPTEMBER 27 (Julian Date 271)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 25.3
Seeley Lake Ranger Station; 3-day running mean ERC: 21.0
Gleason's Resort; 3-day running mean ERC: 18.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 20.6%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 21.3%
Gleason's Resort; 3-day running mean 10 Hr: 22.6%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 18.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 19.3%
Gleason's Resort; 3-day running mean 1000 Hr: 19.3%

Regional Weather: Clouds overnight kept temperatures mild with 40's being reported by most stations. Butte and West Yellowstone were the coolest locations with 35 degrees and Miles City was the warmest at 50. A Pacific weather system moved through western Montana during the morning producing light rain showers and drizzle mostly west of the divide and the northern portion of the central plains. Eastern Montana was experiencing increasing cloudiness. By the afternoon the high temperatures ranged from 55 at Cutbank to 72 at

Broadus. Rain continued into the night with the heaviest occurring west of the divide (Bushey, 1989).

SEPTEMBER 28 (Julian Date 272)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 23.6
Seeley Lake Ranger Station; 3-day running mean ERC: 19.3
Gleason's Resort; 3-day running mean ERC: 19.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 21.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 22.3%
Gleason's Resort; 3-day running mean 10 Hr: 21.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 18.6%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 18.6%
Gleason's Resort; 3-day running mean 1000 Hr: 19.6%

Fire was flown with Xedar (infrared device) and fire activity was detected in Mineral and Meadow Creek (USDA Northern Region, 1989).

Regional Weather: During the night the temperatures fell into the 30's and 40's across the Region. Lows ranged from 27 at Butte to 48 at both Jordan and Miles City. Dense morning fog formed at Glacier International Airport near Kalispell reducing visibility to 1/4 mile. Rain continued falling in many locations during the early morning hours and gradually faded out by about noon. The rains over the past several days had distributed .1 to .3" across most of the Region except for the northern half of eastern Montana. Northern Idaho received a good soaking with a few areas receiving over an inch. Afternoon skies started to clear in the west and were partly sunny, but remained cloudy in the east. Temperatures warmed into the 50's and lower 60's. By 1800 hrs Monida Pass was the cool spot at 53 degrees while Thompson Falls recorded 66. East of the continental divide westerly winds were reported at some location from 15 to 30 MPH. Rains lingered along the eastern Montana border until about midnight with Broadus receiving some much needed rain and Baker and Hardin getting about a .25" with other reports running to less than a .1" (Bushey, 1989).

SEPTEMBER 29 (Julian Date 273)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 28.0
Seeley Lake Ranger Station; 3-day running mean ERC: 23.3
Gleason's Resort; 3-day running mean ERC: 21.6

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 15.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 15.0%
Gleason's Resort; 3-day running mean 10 Hr: 18.6% (last reading for the season)

Lincoln Ranger Station; 3-day running mean 1000 Hr: 19.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 19.0%
Gleason's Resort; 3-day running mean 1000 Hr: 20.0% (last reading)

Regional Weather: During the night temperatures cooled into the 30's and 40's. At 0500 hrs temperatures ranged from 34 at Butte to 51 at Great Falls. West Yellowstone eventually recorded the coldest morning temperature at 27 degrees. Washington and Idaho had clear night skies with similar temperatures in the 30's and 40's. As the day progressed most of Montana was under sunny skies, warm temperatures and generally light winds. Along the east slopes of the Rockies the winds were gusting at a breezy 20 to 30 MPH at times. By 1800 hrs most stations had warmed into the 70's and ranged from 68 at Kalispell and Miles City to 84 at Thompson Falls. These highs were approximately 15 degrees above normal for the time of the year (Bushey, 1989).

SEPTEMBER 30 (Julian Date 274)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 30.3
Seeley Lake Ranger Station; 3-day running mean ERC: 26.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 12.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 11.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 19.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 19.0%

Regional Weather: Skies were clear across the Region this morning as high pressure continued to build. Winds were blowing 10 to 20 MPH along the east slopes of the Rockies but were light elsewhere in the Region. Overnight lows were in the 30's and 40's west of the divide, and mostly in the 50's east of the divide. At 0500 hrs temperatures ranged from 37 at Kalispell to 58 at Great Falls. Drummond eventually acquired the honors of the coolest location for the morning with 35 degrees. West Yellowstone may have been cooler, but failed to report in. During the afternoon a weak cold front moved out of Canada across the hi-line. Temperatures had warmed up quickly in the morning but stabilized in the 70's after the cold front passed. Northerly winds associated with the front were gusting to 25 and 35 MPH. High temperatures were mostly in the 70's and low 80's, and ranged from 73 at West Yellowstone to 84 at Thompson Falls (Bushey, 1989).

OCTOBER 1 (Julian Date 275)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 31.3
Seeley Lake Ranger Station; 3-day running mean ERC: 27.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 10.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 18.6%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 19.0%

Xedar recon again detected activity, but noticeably less (USDA Northern Region, 1989).

OCTOBER 4 (Julian Date 278)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 35.6
Seeley Lake Ranger Station; 3-day running mean ERC: 26.0

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 11.0%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 10.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 17.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 19.0%

Weather stayed dry. North slopes retained moisture levels, but more southerly aspects were dry (USDA Northern Region, 1989).

OCTOBER 12 (Julian Date 286)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 39.3
Seeley Lake Ranger Station; 3-day running mean ERC: 28.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 10.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 11.0%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 16.0%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 18.0%

Xedar flight didn't detect hot spots (USDA Northern Region, 1989).

OCTOBER 14 (Julian Date 288)

Fire Danger Rating: Lincoln Ranger Station; 3-day running mean ERC: 34.6
Seeley Lake Ranger Station; 3-day running mean ERC: 21.3

NFDRS Fuel Moisture:
Lincoln Ranger Station; 3-day running mean 10 Hr: 13.3%
Seeley Lake Ranger Station; 3-day running mean 10 Hr: 20.3%

Lincoln Ranger Station; 3-day running mean 1000 Hr: 16.3%
Seeley Lake Ranger Station; 3-day running mean 1000 Hr: 18.6%

Fire declared controlled (USDA Northern Region, 1989).

From the date of ignition until the control date, a total of 112 days elapsed.

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